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ABSTRACT

The document contains Parts B and C of the report on the Manpower Requirements Projection Model (MRPM) validation study and state surveys (see EC 032 848), which formed Phase III of the Study of the Need for Educational Manpower for Handicapped Children and Youth. Prepared primarily for use by persons responsible for the management and administration of state special education agencies, Part B provides a non-technical description of the purpose and use of the MRPM. Guidelines for the preparation of input data for, and analysis of output reports from, the model are given. In Part C, intended for the technically oriented user of the MRPM, technical details necessary for understanding the model formulations and the related parts of the computer programs are provided. The MRPM was developed to enable state or local administrators estimate manpower requirements and handicapped child population. (See EC 032 847-EC 032 848 and EC 032 850-EC 032 851 for related information.) (KW)

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PART B

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OPERATIONS RESEARCH, Inc.
SILVER SPRING, MARYLAND

STUDY OF THE NEED FOR EDUCATIONAL MANPOWER FOR HANDICAPPED CHILDREN AND YOUTH— PHASE III REPORT

PART B—SPECIAL EDUCATION STAFF USERS GUIDE

1 May 1970

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PREFACE

The "Study of the Need for Educational Manpower for Handicapped Children and Youth—Phase III Report" has been organized so that appropriate parts of it may be conveniently distributed to those most immediately concerned with the content of each part. The general content of each part is as follows:

- Part A, Phase III Final Report, contains the overall report on the Manpower Requirements Projection Model (MRPM) validation efforts and the activities, findings, and conclusions of the state survey. Its appendices also contain implementation cost estimates and summaries of the enrollment and employment data collected during the state survey.
- Part B, Special Education Staff Users' Guide, contains both the general and the detailed guidance necessary for non-technical oriented personnel for understanding and implementation of the MRPM.
- Part C, Manpower Requirements Projection Model—Technical Documentation of the Computer Program, which is written for the technically oriented user of the MRPM, provides the technical details necessary for understanding the model formulations and computer programs.
- Part D, State Analysis Reports, includes individual reports on each state's special education information flow.

Parts B and C are bound together in one volume; Part D is divided into three volumes for ease in handling.

PART B

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I. INTRODUCTION

1.1 This document has been prepared primarily for the use of those who are responsible for the management and administration of state special education agencies. Its purpose is to provide (a) a non-technical description of the purpose and use of the Manpower Requirements Projection Model (MRPM) and (b) guidance in the preparation of input data for, and analysis of output reports from, the model.

1.2 Sections I through V contain a discussion of the model background, the benefits of model application, possible implementation constraints, and a model description. These sections should be of particular interest to the higher echelons of special education administration since they provide the basic information necessary to an understanding of the model's potential, application requirements, and working principles without involving the level of administrative detail necessary to implement the model. Sections VI through VIII contain a detailed description of the model workings, instructions for implementation, and analysis of model output reports. These sections should be thoroughly reviewed by special education staff personnel who will be immediately responsible for model implementation. Although this material is directed toward non-technically oriented personnel, the subject matter does require a detailed presentation and thorough study by the user if implementation is to be achieved.

BACKGROUND

1.3 Increased social awareness of, and improvements in, diagnostic, educational, and technological methods for educating handicapped children have greatly expanded the need for programs to serve these children. Consequently, although the requirements for personnel with the specific skills and/or extensive training needed to staff these programs has increased, such manpower is not readily available from existing sources. Provision must be made for accurately projecting future needs, so that the level of special education manpower training

programs can be established and the necessary and appropriate recruiting policies can be implemented. The resulting manpower reservoir can then be tapped to provide the needed personnel.

1.4 Present methods of anticipating manpower needs are often inadequate because all elements that affect the determination of these requirements are not always considered. These projections may also be inaccurate because of a lack of adequate guidelines; e.g., handicapped child prevalence rates and personnel/pupil contact ratios used may not reflect actual state practices, policies, and operations.

ADVANTAGES OF USING MODEL TECHNIQUES

1.5 Under the sponsorship of the Bureau of Education for the Handicapped (BEH), Operations Research, Inc. (ORI),has developed a mathematical model that provides the framework for systematic consideration and evaluation of all elements contributing to the determination of special education manpower needs. The basic objectives of the model are to provide special education agencies with a basis for projecting special education manpower requirements and to encourage long-range planning to overcome anticipated shortages.

1.6 A model is the mathematical expression of the relationships that exist among the relevant factors to be considered in planning a course of action. The resultant calculations produce quantified solutions based upon the values assigned to the factors. By varying those assigned values, a comparison of results can be used to choose an optimal plan of action.

1.7 The advantages to the use of a model to assist in the development of plans are that

a. By letting planners see the implications of major decisions, they can spot potential problem areas and discover opportunities for remedial or preventative action.

b. By comparing past performance with alternative courses of action, a repetition of past mistakes can be avoided.

c. By applying long range planning, special education personnel can cast a longer look ahead, with freedom to examine hypothetical solutions before decision time becomes critical.

d. By providing the means for the rapid generation of revised plans, new directions can be quickly derived to meet unforseen contingencies.

MODEL CONCEPT

1.8 The MRPM is essentially a management and planning tool for use at the state level. Conceptually, it is aimed at providing state special education agencies with a logical, organized framework in which to consider and apply all of the factors affecting special education manpower requirements, in order to project future manpower requirements. The model is intended to provide

users with a projection mechanism which will function using basic operational data (at the level of detail required for input to the model) but also allow users desiring to do so to introduce factors relating to more sophisticated variables affecting special education. The basic factors with which the model deals in arriving at projections of manpower requirements include

- Number of children that require special education, including enrolled, diagnosed and waiting to be enrolled, and annual additions to the handicapped population (newly diagnosed)
- Various educational programs and personnel/pupil contact ratios for each handicapping condition at each level of education
- Number of attritions from the handicapped population including dropouts, graduates, returns to normal education, children who move away,and mortality
- Number of children progressing from lower level educational groups to higher educational groups
- Influence of such factors as medical and diagnostic technology, and modifications in educational policy or practice on the special education population.

The manner in which these factors are handled by the model and the manner in which they relate to one another when used to project manpower needs are discussed in detail in subsequent sections of this guide.

MODEL ATTRIBUTES

1.9 The model is responsive to a number of situations that could be encountered by a state in attempting to formulate relatively sophisticated projections of its special education manpower requirements. The following discussion identifies certain of these situations and the capability of the model to respond to them.

Varying Definitions

1.10 The definitions of the various handicapping categories constituting the handicapped child population vary among state education agencies. Suppose that State A defines a category more comprehensively than does State B. The application of State A's definition to State B for the purpose of determining the actual needs of B could result in the calculation of a significantly different population size with a different composition of handicapping attributes, requiring different types and numbers of personnel.

1.11 The elements of the model are defined at a sufficiently low level of detail to allow each state to insert the definition data which depict its own unique situation most accurately. While the model incorporates the major determinants of manpower needs, its completely general nature allows the user to insert

whatever data element values and whatever definitions best describe the circumstances underlying his estimates.

Varying Educational Practices

1.12 Educational practices, which can vary with regard to both educational environment and personnel utilization, exert a definite influence on the number of children who can be served by each personnel type. The easiest approach to handling these influences would be to assign arbitrarily determined values to these ratios to represent the values implied by "normal" or "representative" practices among agencies and institutions. This would, of course, reduce the credibility of the resulting estimates and force those estimates to reflect practices not necessarily followed or anticipated by the individual education agency. Here again, the model is structured in such a manner that the user is permitted to assign the values which accurately reflect the actual or anticipated ratios in his state for each educational program at each educational level.

Anticipated Dynamics of Special Education

1.13 The MRPM requires quantitative expressions of those variables which reflect current or anticipated trends in special education which are relevant to manpower needs. In fact, without these requirements, it would cease to be a useful model in the sense of expressing the influence of real-world forces on the variables in question, and would constitute only a simple device for generating projections that may be insensitive to the future impacts of these forces. However, assessments of both the direction and relative influence of trends in special education programming are invariably subject to controversy and disagreement. Disagreements may occur regarding growth in the category populations of handicapped children, the pace at which proportionate increases in the participation of handicapped children in special education will occur, changes in program policies, etc.

1.14 The model, in generating estimates, offers the advantage of explicitly revealing, in a quantitative fashion, the assumptions that a user makes regarding such trends in special education. Further, where there is disagreement as to the occurrence of a trend, alternative values may be inserted in the model, and alternative estimations of requirements may then be compared for planning purposes.

MODEL VALIDATION

1.15 Immediately following the development of the MRPM by ORI, a model demonstration was performed in order to test the workings and outputs of the model in a real-world situation. The demonstration focused on a large, local school district rather than at the state level because of the likelihood that all the necessary data would be more readily available at the local level. It was felt that conducting the demonstration at this level would provide the best opportunity for exercising the full capability of the model with respect to both handicap groups and personnel occupation groups. A large midwestern special school district was selected for the demonstration because of the extent of its programs

for handicapped children and also because of the availability of historical records. The collected data were input to the mathematical model, and manpower needs were projected. In this test case it was possible, on a year-to-year basis, to compare predicted requirements against actual needs. The results proved to be very comparable, demonstrating the validity of the mathematical formulations used in the model, and demonstrating the capability of the model to accurately project, over time, the manpower requirements for special education programs.

II. BENEFITS OF MRPM APPLICATION

2.1 The MRPM is intended for use at the state level. The following section discusses areas of specific potential value to be realized through state-level application of the model.

IMPROVED FLOW OF INFORMATION

2.2 During the model development phase, it was realized that not all of the data elements required to utilize the model effectively were currently available at the level of the state education agency. In the subsequent survey phase, visits were made to each state special education agency (or its equivalent) to evaluate the capability of existing information flows to produce the required data elements. While in many states it was determined that the existing information flow did not include all the necessary data, it was also concluded that the required data elements were basic information useful for management and monitoring of operations. An initial benefit of the implementation of the MRPM, therefore, is that a more organized and detailed amount of data will become available. This will be useful not only for manpower projection purposes, but for other evaluative and projective purposes.

2.3 One of the concepts of the model is that the data elements be representative of the total identified handicapped child population in the state. To accomplish such a data base, other state agencies, and where possible, private institutions responsible for handicapped child education, will contribute input data. The net result will be a centralized and representative data base which can be used to evaluate the handicapped child education problem. Any contributing agencies should, of course, have access to the data base. This should encourage inter-agency communication and coordination.

IMPROVED PLANNING DATA

2.4 The model has been designed for application by state education agencies and, when fully implemented, will assist each state in the systematic prediction of its own special education manpower needs, based upon that state's individual educational characteristics. The model will simulate present and future manpower needs under varying assumptions regarding changes in personnel utilization, the mix of educational environments, the child participation rate, or any combination of these variables. Therefore, estimates of present requirements can be generated,based on both existing service levels and existing educational program choices,or based on more ideal circumstances.

2.5 Future requirements can be estimated in a similar manner. The results of these simulations will provide the states with important insights regarding manpower implications of improving service levels and programs. Once the requirements are projected, the manpower gap (difference between requirements and supply) can be determined. With this information, the state can initiate policies, procedures, and programs to alleviate any future shortages in special education manpower which may be identified. For example, scholarships in the field of special education may be made available at the state university, and programs may be instituted to reduce attrition and/or draw inactive special education personnel back into the field of education for handicapped.

2.6 Statistics pertaining to many essential elements of the model are also vital to local and state education agencies and legislatures for the planning and budgeting of facilities, educational programs, and personnel training.

PROVIDE BASIS FOR NATIONAL ANALYSIS

2.7 Because of the Federal involvement in special education programs, there is an ongoing requirement to provide information to the Federal agencies. The data base established for model application will provide a broad base for responding to such requests for information. In addition, the projective information resulting from the model application will also be useful to the Bureau of Education for the Handicapped as a guide in the formulation of training priorities and Federally-assisted training programs.

III. POSSIBLE IMPLEMENTATION CONSTRAINTS

3.1 During the state survey visits, almost all of the state special education agencies agreed with the concept of the MRPM. However, some problems were mentioned that could retard the development of the information flow necessary to the implementation of the model. It is recognized that there can be obstacles to the initiation of any new procedures, but there are also inducements to overcome these obstacles. For example, a possible obstacle to the development of the information flow may be the shortage of state level special education staff or lack of staff skills to implement the system. This may be true in some instances, but it is also true that some special education staffs spend much valuable professional time performing the administrative and clerical tasks necessary to respond to requests for special reports, without establishing the procedures for a continuous flow of data. As a result, the next time a request for a similar report is made,the whole inefficient operation has to be repeated. An initial "investment" of staff time in the development of an organized and automated information flow would alleviate much of this nonprofessional work load with comparatively much less time required to maintain the information flow.

3.2 The absence of staff capability to design and implement an information system can, in some cases, be resolved by tapping the capability which usually exists in the state data processing center (these centers are normally responsible for supporting the special education function). The special education agency may not currently be utilizing this service because they are unfamiliar with its capability, or because of lack of priority necessary to obtain assistance. In the latter instance, priority can best be obtained by first creating the requirement for services and then pressing for the necessary assistance.

3.3 There is, in some states, an autonomy of operation allowed at the local level that deprives the state special education agency of the "leverage"

necessary to induce information flow to the state level. The provision of data to the state level does not have to deprive the local agencies of their autonomy, and it can greatly improve the state special education agency's ability to plan for the betterment of the statewide handicapped child education programs. The competition for available funds among the various state agencies is intense, and in order to obtain a satisfactory allocation of funds for special education, reliable data illustrating the severity of the need for resources are needed.

3.4 In some states, the extreme shortage of special education manpower suggests that the projection of special education manpower requirements would not really produce useful planning information because of the already obvious long-term problem. While the severity of the problem may seem to preclude application of the model for manpower projections in the near future, it does not detract from the advantages inherent in an information flow that can provide the data necessary to support the ongoing management functions of the agency.

3.5 Further, while projections of manpower requirements may not appear to be a priority need for a given special education agency, the capability of the model to generate other valuable data projections should not be overlooked. Of importance to all special education planners is the estimation of future handicapped child population size. This estimate is, of course, the basic intermediate output of the MRPM; as such, it should be of value at local, state, and Federal levels.

IV. DEFINITIONS USED IN THE MRPM DESCRIPTION

4.1 Before describing in further detail the logic of the model structure, the definitions of some of the terms used should be thoroughly reviewed and understood. This will greatly assist in the understanding of the model description, operations, and applications which follow.

Target Group—A group of children in the same educational level having similar educationally relevant handicaps; e.g., educable mentally retarded children of elementary school age.

Service Level—The proportion of children within a target group receiving special education services; e.g., 80 percent of the blind children of elementary school age are receiving special education services.

Educational Program—The type of classroom/school environment providing special education services to handicapped children, identified in this study primarily for determining the differences in personnel/pupil contact ratios and manpower requirements; e.g., education in residential schools, special classes in regular schools, resource rooms, itinerant programs, etc.

Educational Program Weight—The proportion of children being served within a target group who are enrolled in an educational program; e.g., 60 percent of the blind children of elementary school age who are receiving special education services are enrolled in residential school educational programs.

Educational Program Mix—The set of program weights associated with a target group; e.g., of the blind children of elementary school age who are receiving special education services, 60 percent are served in residential schools, 30 percent are served in special classes in regular schools, and 10 percent are served in resource room programs.

Personnel/Pupil Contact Ratio—The number of pupils in a target group who are served by a particular personnel type; e.g., a speech therapist who serves 120 different speech handicapped children of elementary school age during a school year would have a personnel/pupil contact ratio expressed as 1/120. This term is often referred to as teacher/pupil ratio; however, the term "personnel" is used to broaden the concept to include other personnel such as therapists, aides, etc.

V. BASIC MODEL DESCRIPTION

5.1 The following section is intended to outline the basic workings of the MRPM as it translates the educational needs of a state's handicapped child population into special education manpower requirements. The model itself comprises a number of mathematical relationships or calculations, dealing essentially with the projected handicapped child population of the state, the personnel/pupil contact ratios utilized in the educational programs in which this population is served, the factors which affect the dynamics of special education, and the resulting manpower requirements for the staffing of these educational programs.

TARGET GROUP POPULATION

5.2 The primary foundation for the projection of special education manpower requirements is essentially the handicapped child population that is to be served in a state. The vast majority of all data that would be collected by a state special education agency for input to the projection model would relate to the definition and the determination of the size of this handicapped child population. The model does not deal with the handicapped child population as a total entity. Rather, it deals with the population in terms of target groups.

5.3 In order to determine accurately the number of children in a target group who will require special education in any given year, more information is necessary than the number of children enrolled in the state's special education programs. To this must be added counts of children who have been diagnosed as handicapped but not yet enrolled in a program (i.e., who are on a waiting list), counts of children who are newly diagnosed as handicapped for the first time that year (i.e., annual new entrants), and counts of children who move into the target group from a lower level target group representing the same handicapping condition.

5.4 From this total target group must be deducted the counts of children who attrite from the handicapped child population (e.g., move out of the school district, return to regular education, graduate, etc.).

5.5 In essence, the model will include all identified children in a target group, regardless of their status with regard to enrollment, and will eliminate from the target group all children who do in fact leave it, for whatever reason. A target group, then, should include all children having a specific handicapping condition, and at a specific educational level, who are known to be eligible for special educational services. This concept is illustrated in Figure 1.

5.6 While the model does work primarily with fairly basic data on entrance to and attrition from a given target group, it is also capable of taking into account the less obvious variables, or factors, which could affect the size of a state's target group population over a period of time. These factors may be quantified and then input to the projection model. Their use would enable the model to be more responsive to real-world influences of technology and policy change in its projection of target group population size.

5.7 Basic areas of influence on target groups are:

a. Medical technology factors which could have an impact on the treatment of handicaps, and thus on the rate at which handicapped children leave the target groups

b. Diagnostic technology factors which could have an impact on the rate at which handicapped children enter the target groups (i.e., are diagnosed as needing special education)

c. Educational policy/practice factors which could have an impact on the rate at which handicapped children enter or leave the target groups.

5.8 In order to define clearly the requirement for special education for a target group, the model also utilizes a factor called educational program weight, which represents the extent of participation in a particular educational program by children from the specific target groups. Within a state, several different types of educational programs may exist. Children from one specific target group may in fact be served in more than one type of program. It is important for a state to know the extent or rate of participation of target group children in the various education programs available, in that this directly affects the projection of the type and quantity of manpower needed to serve the total target group.

MANPOWER REQUIREMENTS

5.9 The foregoing sections have briefly described the model approach to projection of the target groups that require special education. With target group size established and the extent of target group participation in the

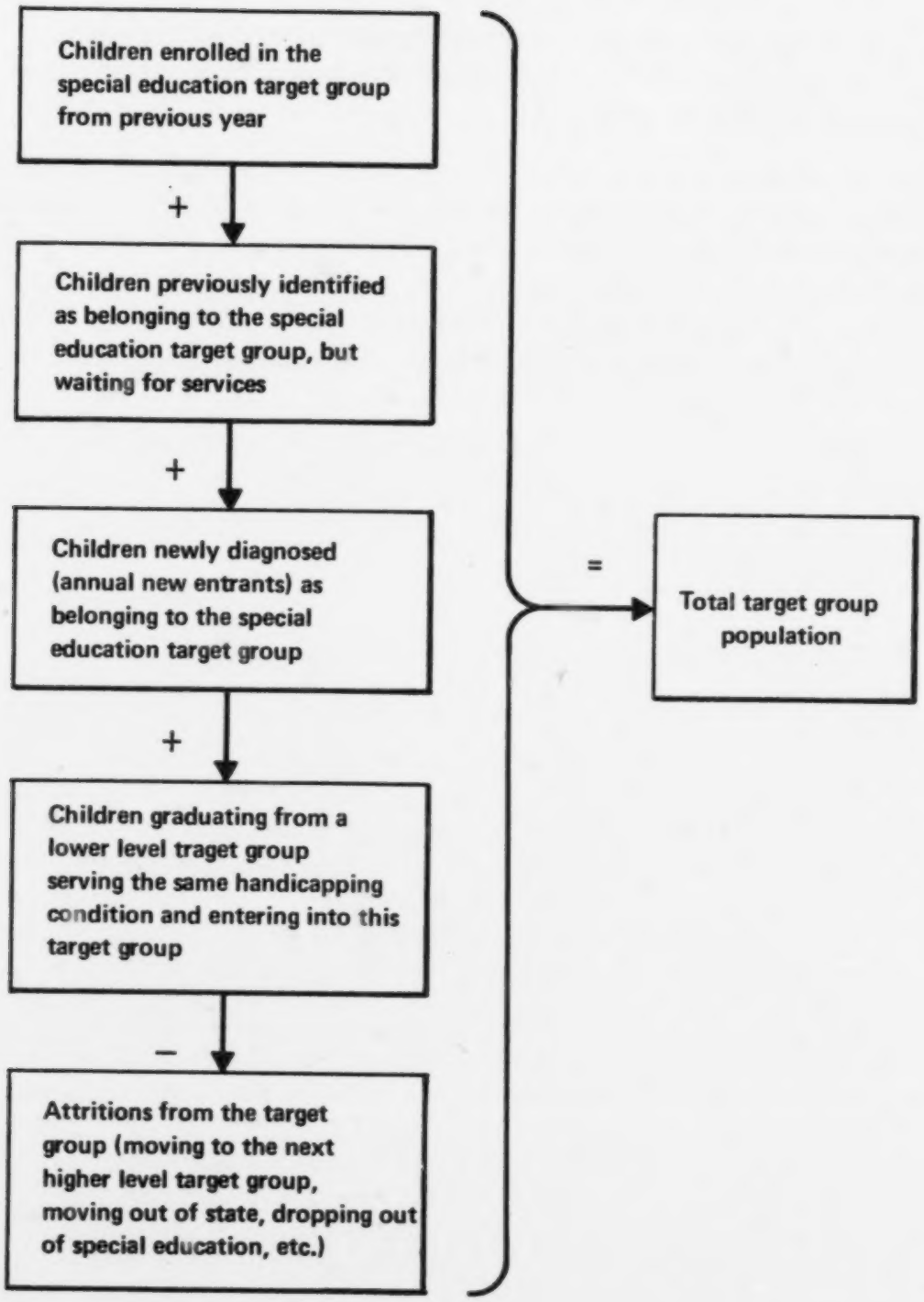
Children enrolled in the special education target group from previous year
+
Children previously identified as belonging to the special education target group, but waiting for services
+
Children newly diagnosed (annual new entrants) as belonging to the special education target group
+
Children graduating from a lower level traget group serving the same handicapping condition and entering into this target group
–
Attritions from the target group (moving to the next higher level target group, moving out of state, dropping out of special education, etc.)
=
Total target group population

FIGURE 1. BASIC ELEMENTS OF A TOTAL TARGET GROUP POPULATION

various types of educational programs determined, the additional data elements required to project special education manpower requirements are:

a. The types of personnel (occupations) that will serve the children on a direct-contact basis

b. The personnel/pupil contact ratio attached to each occupation within each type of educational program and each target group.

5.10 Having established these factors, the projection of special education manpower needs can be determined by the model in a fairly straightforward manner. By applying the personnel/pupil contact ratio for each occupation/program/target group to the appropriate projected target group population, the model generates the total projected manpower requirements for each special education occupation. Figure 2 illustrates the logic involved in this process.

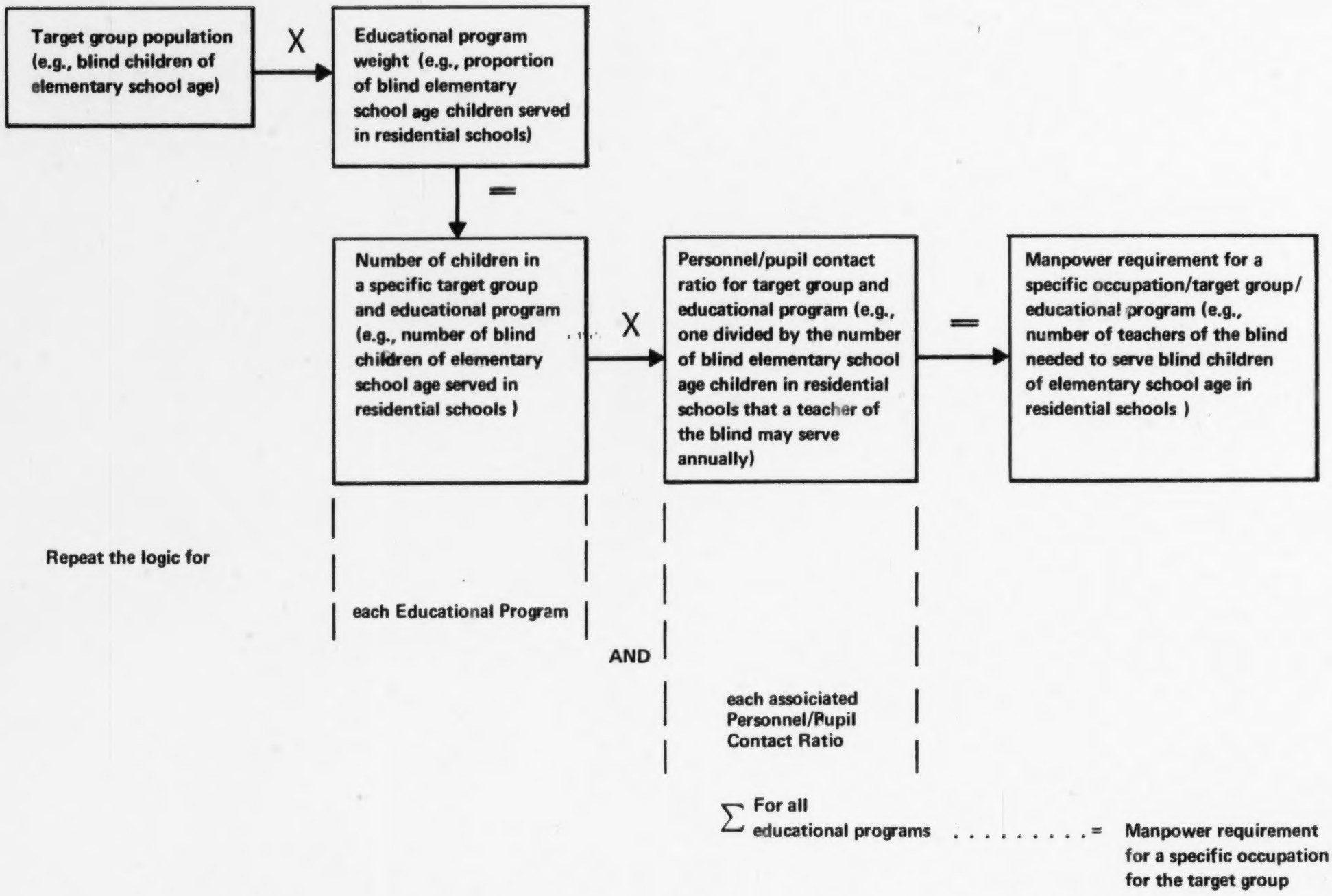
Target group population (e.g., blind children of elementary school age)
X
Educational program weight (e.g., proportion of blind elementary school age children served in residential schools)
=
Number of children in a specific target group and educational program (e.g., number of blind children of elementary school age served in residential schools)
X
Personnel/pupil contact ratio for target group and educational program (e.g., one divided by the number of blind elementary school age children in residential schools that a teacher of the blind may serve annually)
=
Manpower requirement for a specific occupation/target group/ educational program (e.g., number of teachers of the blind needed to serve blind children of elementary school age in residential schools)
Repeat the logic for
each Educational Program
AND
each assoiciated Personnel/Pupil Contact Ratio
∑ For all educational programs . . . . . = Manpower requirement for a specific occupation for the target group

FIGURE 2. PRIMARY ELEMENTS OF MANPOWER REQUIREMENTS PROJECTION

VI. DETAILED MODEL DESCRIPTION

6.1 The preceding sections of this Special Education Staff User's Guide have presented the basic information concerning the model potential, application requirements, and working principles of the MRPM. The remainder is addressed to those special education administrators and staff who are interested in, or must know, the details necessary for model implementation.

OVERVIEW

6.2 In the development of the model, it became evident that an approach to the educational needs of a subset of the handicapped child population, defined in terms of the educationally relevant handicapping condition and educational level of such children and termed target group in the model formulation, is translated into manpower requirements on the basis of the educational program(s) in which these children would be expected to participate. The model uses this concept of educational programs to enable the specification of differing personnel/pupil contact ratios and manpower requirements. The advantage of this approach lies in the ability it provides to capture both the influence of educational program choice on manpower requirements and the range of personnel types required.

6.3 The Manpower Requirements Projection Model employs an iterative technique in the calculations of the projected handicapped child population (by target groups), the projected personnel/pupil contact ratios, and the resulting special education manpower requirements. This estimating methodology can accommodate the varying handicap and personnel definitions and educational practices employed among the states. The detailed formulation of the model permits the user to simulate the effects of changes in handicap category definitions, educational program mixes, or differential rates of growth among target

group populations, as well as the effects of other real-world influences. The model also permits the user to account for the fact that the services of personnel within a given occupation are frequently required by more than one type of handicapped category.

6.4 The mathematical formulation of the model enables the user to simulate present and future requirements under varying assumptions regarding changes in the proportion of a target group to be served, the educational program mixes (as manifested in personnel/pupil contact ratios) offered a target group, or any combination of these variables. Estimates of present requirements can therefore be generated on the basis of both existing service levels and program choices, as well as selected theoretical circumstances. Future requirements can be estimated in a similar manner. The results of these simulations will provide important insights regarding the manpower implications of improving service levels and/or programs. In a similar manner, they will indicate the impacts on special education manpower requirements of target group growth and observable changes in educational policies and practices.

6.5 The model is designed for use in the estimation of manpower requirements at either the state or local level and also at regional and national levels. Its formulation permits the influence of differences in target group definitions, values of entrance and attrition rates, program choices, and other detailed variables to be reflected in the requirements estimates. As a result, the compilation of these estimates to form estimates of manpower needs at the national level will be more representative, and thus more credible, than any produced by a model employing input variables and parameters fixed in value at the national level.

BASIC FORMULATION

6.6 The number of personnel in each occupation that is required for a particular target group population of children, at any point in time, is defined as a multiplicative function of the target group population, the personnel/pupil contact ratio, and the target group participation factor, or service level (proportion of the target group population participating in special education). Target groups are defined on the basis of the handicap and age of the children to be served. For an individual type of occupation for a given target group, the personnel/pupil contact ratio depends on the educational program in which the personnel are employed and is a characteristic of the program. The personnel/pupil contact ratios used in the model are a weighted average of all personnel/pupil contact ratios for each of the educational programs in which the target group participates.

6.7 Mathematically, the basic estimating equation for the number of personnel required may be written

$$D = (T/P)\ (TG)\,\varphi \qquad (1)$$

where D = number of personnel required
T/P = weighted personnel/pupil contact ratio used in the model
TG = target group populations
φ = target group participation factor, or service level $(0 \leq \varphi \leq 1)$.

The model recognizes that the requirement for personnel in an occupation type, e.g., speech correctionists, at any time can derive from the needs of more than one target group. In such an event, the total number of personnel of a specific type required is the sum of the number required by each target group. In the model, therefore, equations such as (1) are applied to make estimates of personnel requirements by occupation type and target group population at any point in time; these are summed for all target groups to obtain the total personnel requirement for an occupation type.

6.8 These relationships, along with the mathematical expressions associated with them, are illustrated in Figure 3. Thus, combining the expressions within the boxes to the right of the equal sign, the model is mathematically expressed as

$$D_{kt} = \sum_{i=1}^{m} \left[(T/P)_{ki}\,(TG_i)\,\varphi_i \right]_t \qquad (2)$$

where k = occupation type
i = target group
t = point in time
m = the total number of target groups under consideration.

6.9 The ability of the model to estimate future requirements and account for changes in target group populations, program mixes, and personnel/pupil contact ratios is provided by the set of formulas used to calculate the variables (TG) and (T/P). [1] Each of these sets of formulas is termed a submodel, that is, a model within a model (as defined previously in Section I, page B-2). These submodels generate the projected values of the variables (TG) and T/P) at a given point in time, t; the projected values are then inserted into the requirements estimating equation (2).

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[1] It is reasonable to assume that subjective judgments can be applied to estimate future values of φ_i with the same degree of reliability that could be obtained using quantitative relationships. Furthermore, values of φ_i are somewhat within the control of the state or geographical area special education agency.

Total personnel requirement for a specific occupation type at a specific point in time	=	Personnel requirement for first target group for that occupation type at the same point in time	+	Personnel requirement for the second target group for that occupation type at the same point in time	+...	Personnel requirement for as many target groups as exist in the state special education structure for which the services of the occupation type are required
D		$(T/P)_1 (TG_1) \phi_1$		$(T/P)_2 (TG_2) \phi_2$		$\ldots (T/P)_m (TG)_m \phi_m$

FIGURE 3. VERBAL/MATHEMATICAL EXPRESSION OF TOTAL PERSONNEL REQUIREMENTS ESTIMATING EQUATION

6.10 In its entirety, the model comprises a recursive system of equations, i.e., a system in which the values of independent or determining variables in one equation are the dependent or determined variables in previously computed equations. The following subsections describe the methodology and quantitative relationships underlying the projection of (TG) and (T/P). The detailed mathematical development of the model is contained in Part C, Manpower Requirements Projection Model—Technical Documentation of the Computer Program.

TARGET GROUP SUBMODEL

6.11 A target group (TG_i) has been so defined that the target population is classified in educationally meaningful terms according to both handicapping condition and age/education level. The total target population is derived as the sum of the TG_i populations. In an aggregate sense, the population of TG_i changes over a period of time, owing to the difference between the total number of new entrants and the total number of attritions. Thus, given the population of TG_i at a point in time, the TG_i population a year later will be the given population plus the number of new entrants to TG_i during the year minus the number of attritions from TG_i during that year. A methodology was developed for computing the numbers of new entrants and attritions over time, given a base value for TG_i.

6.12 The general methodology for the target group submodel is shown in Figure 4. The data inputs and calculations needed to determine the number of attritions from TG_i are shown on the left of the figure, and on the right are the inputs and calculations needed to determine the number of new entrants to TG_i. Each individual target group consists of a number of age levels, indexed by g, which are defined as encompassing all children of a particular chronological age; e.g., age group 2 in a target group might refer to all 7-year-old children. Thus, the total target group population is the sum of the populations of its age levels (see boxes 1 and 14 in Figure 4); applying the methodology of this figure, the calculations for determining entrance and attrition should be made on the basis of individual age levels and summed for the target group.

6.13 The number of children at age level g within a TG_i at time t+1 depends on the number of children in the next lower age level at time t, the number of children who enter TG_i in age level g during the time interval t to t+1, and the number of children who leave the previous age level during the interval t to t+1. For the purposes of the model, the children in the lowest age level of a TG_i at time t are all considered as new entrants. Among these children, a distinction is made between the new entrants to the handicapped child population, and thus new entrants to eligibility for special education, and the entrants to the target group who have graduated the previous year from the next lower education level having the same handicapping condition(s) (TG_{i-1}). This distinction is discussed further in paragraph 6.18. For the sake of completeness, the model would also

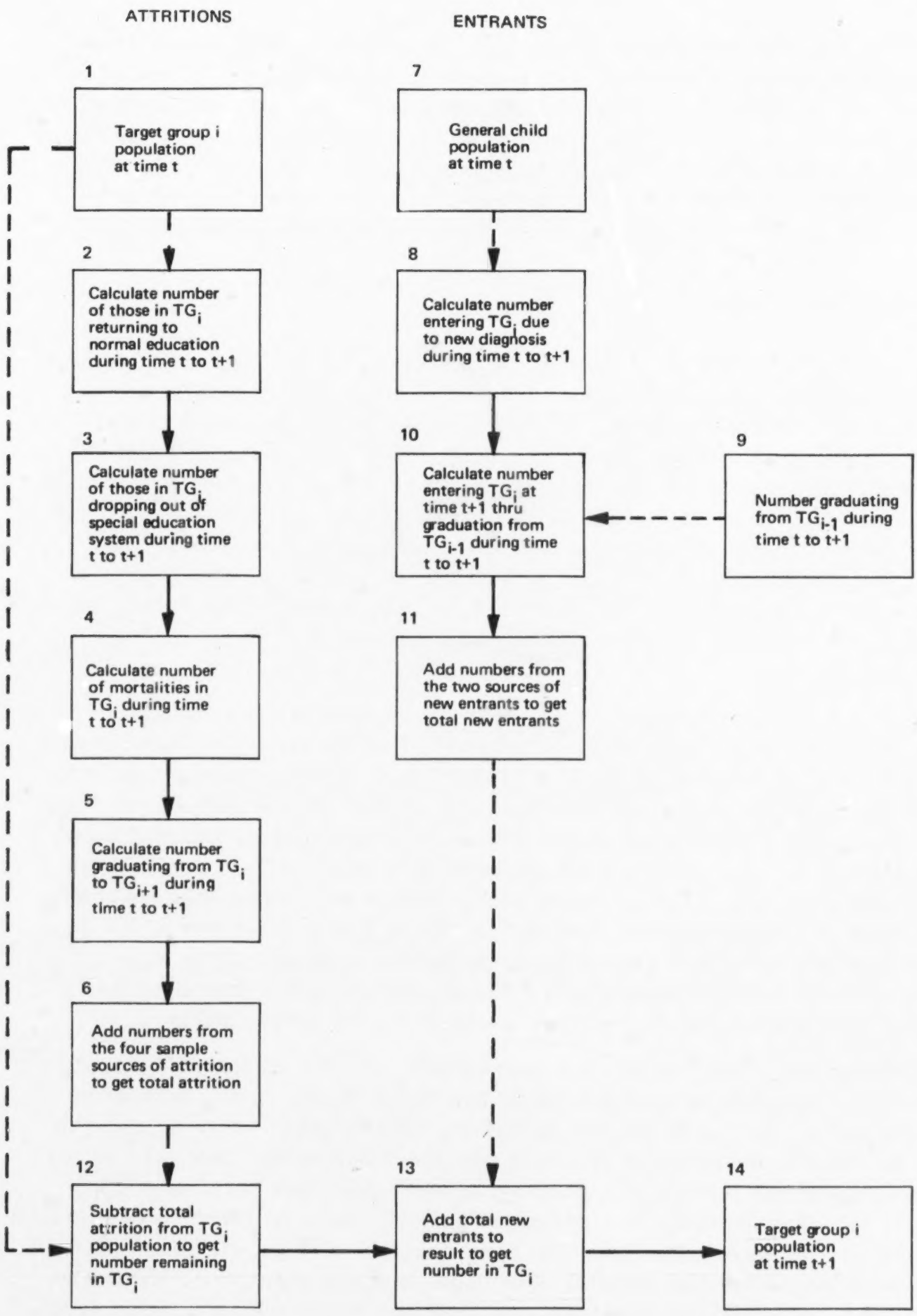
ATTRITIONS
ENTRANTS
1
Target group i population at time t
2
Calculate number of those in TG_i returning to normal education during time t to t+1
3
Calculate number of those in TG_i dropping out of special education system during time t to t+1
4
Calculate number of mortalities in TG_i during time t to t+1
5
Calculate number graduating from TG_i to TG_{i+1} during time t to t+1
6
Add numbers from the four sample sources of attrition to get total attrition
7
General child population at time t
8
Calculate number entering TG_i due to new diagnosis during time t to t+1
9
Number graduating from TG_{i-1} during time t to t+1
10
Calculate number entering TG_i at time t+1 thru graduation from TG_{i-1} during time t to t+1
11
Add numbers from the two sources of new entrants to get total new entrants
12
Subtract total attrition from TG_i population to get number remaining in TG_i
13
Add total new entrants to result to get number in TG_i
14
Target group i population at time t+1

FIGURE 4. METHODOLOGY FOR COMPUTING THE PROJECTED VALUES OF A TARGET GROUP POPULATION

have to account for the movement of children between target groups. However, because children are classified by their major handicapping condition, the numbers involved in such a movement were assumed to be negligible, and the movement was not included in the model.

Attritions

6.14 The causes of attrition from TG_i are grouped into categories according to the reason for attrition, e.g., returned to the normal education system, moved out of the school district, dropped out of the education system altogether, mortality, or any other attrition category that the user may wish to apply. Thus, for each age level within TG_i, a rate (i.e., probability) should be determined for each attrition category that is defined by the user of the model. These rates represent the proportion of children in the age group who will leave TG_i for each respective reason during the interval t to t+1. It is assumed that the children at the highest age level within TG_i who do not attrite for any of these reasons are "graduates" of the target group and move during the interval t to t+1 into the next education level of the same handicapping condition (TG_{i+1}), if the target group exists.

6.15 Note that these attrition rates can be expected to vary over time, depending upon real-world influences such as medical technology and educational policy and/or practice. Factors to account for these influences are included in the model formulation. Using the four sample reasons for attrition listed in the previous paragraph, it is reasonable to assume that as medical technology advances, more children will return to normal education (especially from the physically handicapped target groups) and fewer children will die. Similarly, if educational policy and practice place an increasing emphasis upon retaining children in regular education if at all possible, more children will return to normal education. If educational policy and practice place an increasing emphasis upon retaining children in special education, fewer children will return to normal education, fewer children can be expected to drop out, and fewer children can be expected to move (based upon the assumption that many parents tend to equate quality of service with quantity of service). Further discussion of the assumptions made about these influences and of methods to determine their assumed analytic values is presented in Section IX.

6.16 The model uses these adjusted attrition rates to calculate the number of children who attrite from a target group during a particular time period t to t+1, usually 1 year. To calculate the number of attritions from each age level of TG_i during the time t to t+1, the model applies the appropriate attrition rates to each age level population. These total attritions for each age level are then summed to produce the total number of attritions from TG_i.

6.17 Alternatively, this calculation can be viewed as determining the number of attritions from TG_i due to each of the reason categories specified by the user. The sum of these attritions plus the number of children "graduating" is the total number of children leaving TG_i for the time period (shown in boxes 2 to 6 of Figure 4).

Entrants

6.18 The two source groups from which children may enter TG_i are the general child population and the target group of the previous education level of the same handicapping condition (TG_{i-1}). It is assumed that new entrants to TG_i in age level g, other than g=1 (the lowest age level in a target group), will only be from the first source. For g=1, children may enter from both source groups. The model uses sets of rates (i.e., probabilities), one set for each target group, to calculate the number of children who will enter a target group from the general child population during a particular time period t to t+1, usually 1 year, and always representing the same time period used when calculating attritions. Each of these sets contains, for each chronological age corresponding to each level in TG_i, the proportion of children in the general population of that age who will be diagnosed as needing special education, of the type provided for TG_i, for the first time. These proportions represent the true, or current, new incidence rates for the handicapping condition of TG_i. Each of these sets of probabilities can be expected to vary over time, depending upon real-world influences, e.g., due to changes in diagnostic technology, educational policy and/or practice, and medical technology. Here too, factors to account for these influences are included in the model formulation. By applying these probabilities to the number of children in the general (total) population (at time t) of the chronological age corresponding to each level within TG_i, expected new entrants to each age level of TG_i during time t to t+1 may be calculated. The total number of new entrants to TG_i is then the sum of the number of new entrants to each age group within TG_i (see boxes 8 to 11 in Figure 4).

6.19 Since the probabilities in each set are applied to children in each chronological age within the general (or total) child population, the number of these children must be determined for each future point in time under consideration by the Manpower Requirements Projection Model. If these numbers, by single year of age,[2/] have already been projected for a state or unit for which the model is to be used, they may be inputted into the model, which will obviate the need for the model to compute the projections.

6.20 In the absence of an outside set of projections of the population by age, the model will compute the number of children of chronological age 0 and the numbers of children of ages 1 to 21 in two different ways. The first, the number of births during time t to t+1, is expressed as the product of the projected birth rate and the projected total population, both at time t+1.

6.21 The model calculates the second, using a very simple algorithm or formula. The number of children of a particular chronological age in the general population at time t+1 is assumed to equal the number having the previous age at time t adjusted for mortality, through the application of a survival rate, and net gain or loss due to non-mortality reasons.

2/ Each chronological age between 0 and 21 is needed because the relevant new diagnoses of handicapped conditions come from these ages in the normal population.

6.22 Since this model was never intended to be a sophisticated projector of the general child population, non-mortality net gain or loss (termed net immigration) is simulated, using the net gain or loss to the handicapped child population. In reality, however, the net immigration for a geographical area is based upon a series of complex factors such as economic conditions, weather, and demographic conditions. Clearly, it is preferable to have the user input into the model the general child population projections, ones which reflect more sophisticated assumptions about the factors leading to a net gain or net loss for each chronological age.

PERSONNEL INPUT SUBMODEL

6.23 The choice of educational programs to be provided to any target group has significant implications for manpower requirements; two basic considerations are relevant. First, it is unlikely that the educational needs of any TG_i could be met by a single educational program; rather, a combination of programs would probably be required to meet the individual needs of TG_i members. Second, since personnel/pupil contact ratios may vary among educational programs, changes in the program mix will probably have significant impact on the manpower needs of the children making up the target group.

6.24 Accordingly, the personnel input submodel, generally referred to as (T/P), encompasses for each TG_i, its associated educational programs, the distribution of TG_i population being served among these programs (i.e., the program weights), and the personnel/pupil contact ratios associated with each program. The (T/P) value for the k^{th} occupation inserted in Equation (2) is therefore estimated as the weighted average of the occupation's ratios for each educational program offered TG_i at time t.

6.25 It can be expected that both the program weights and the (T/P) values will change over time. The general trend toward assimilating handicapped children into regular classes rather than placing them in more sheltered environments substantiates the probable variance in the program weights. Changes in requirements among occupations and in educational needs, as well as within occupations' technologies, testify to expected variance in the (T/P) values. Factors, termed personnel input policy and/or practice and educational technology, to account for these influences on the (T/P) values, are included in the model formulation. Ideally, projected values for each program weight should be specified by the user as a reflection of anticipated changes in relative program enrollments. This can be done by inputting into the model the discrete subjective values for the weights for each projection year desired by the user.

REQUIREMENTS CALCULATION

6.26 All the preceding submodel computations are performed for each time period, t, greater than the initial point in time, t=0. These interim results are then combined according to the basic model formulation, Equation (2), to determine the requirements for each personnel type at time t.

RECAPITULATION

6.27 The foregoing describes the logic and computations underlying the derivation of values of TG and T/P to be inserted in the basic model, e.g., Equation (2). For readers with a mathematical orientation, a more concise statement of this process is contained in Part C of this report.

6.28 In projecting target group populations, the system of equations described in the foregoing paragraphs must be used if the model is to be responsive to the dynamics of population growth and the progression of handicapped children through the various educational phases. The discussion has revealed that the number of children in a target group at any point in the future is the net result of a number of forces; to adequately account for these, attention must be paid to both the variables accounting for the movement of children through the various levels of special education, as well as the variables affecting the entrance and attrition from this flow at all relevant points in time.

6.29 The variables determining the personnel/pupil contact ratios required to serve a future target group population have been developed in the personnel input submodel. Traditionally, these variables have been subsumed by the simple means of applying a fixed personnel/pupil contact ratio value to the child population in question. Although such an approach offers the advantage of simplicity of computation, it suffers from the disadvantages associated with oversimplification of the relationships involved. The (T/P) submodel recognizes that the personnel requirements of a given target group population will be influenced by the choice of educational programs offered, their relative importance in terms of the proportion of children in the target group receiving special education who are enrolled in each program, and the occupational requirements of each educational program, as well as the associated personnel/pupil contact ratios.

MODEL USE

6.30 Because of the volume of equations and variables that the Manpower Requirements Projection Model comprises, it would be extremely tedious for a user to perform the calculations manually, and many potential users would thus be deterred from using the model as a working tool. In order to facilitate the use of the model and to standardize the format of the results (for the sake of legibility and ease of understanding), a computer program, called REQMODEL, has been written to perform all of the calculations and the formatting of the output.

6.31 Due to the size limitations assumed for most of the computers available to special education administrators, the following limitations were placed on the extent of simulation that the REQMODEL program can handle: up to 10 years, or time periods, of projection; up to 22 different target groups, each having up to 9 age levels; up to 4 attrition categories, across all target groups; up to 6 types of educational programs; and up to 25 types of personnel. If the user defines a

target group having more than 9 age levels (e.g., speech handicapped—all grades, ages 6-19), it must be separated into two target groups for input into the REQMODEL program; if the definitions of the educational programs, the personnel types, and the associated personnel input proportions of both resultant target groups are the same, the net manpower requirements will not be affected by the separation.

VII. DETAILED DEFINITIONS OF INPUT DATA ELEMENTS

7.1 In use, the computer program REQMODEL requires many elements of information for input. This information can be categorized into five sets of data elements: computer program control parameters, target group populations (the number of children identified as needing special education), target group entrants and attritions (the number of children moving into and out of the handicapped child population), general child population, and special education simulators (data used to simulate special education).

COMPUTER PROGRAM CONTROL PARAMETERS

7.2 These data elements are used to define the target groups (in terms of number and their characteristics) and the special education characteristics, and to select the user options available. The following, not in the order of actual input, are the specific data elements in this set which must be provided:

a. Target group definition

- Number of target groups used during this application of the model (maximum of 22).
- Prose title of each target group (e.g., Educable Mentally Retarded—Elementary Level); the set of these target groups is considered as a list by the model (see Table 1).
- Number of age levels (each corresponding to a chronological age) within each of the target groups (maximum of 9).

TABLE 1

EXAMPLE OF TARGET GROUP LIST AND
CORRESPONDING INDICATOR VALUES

TG No.	Target Group Title	Indicator Value
1	Blind — Preschool Level	0
2	Blind — Elementary Level	1
3	Blind — Secondary Level	1
4	Partially Sighted — Elementary Level	0
5	Partially Sighted — Secondary Level	1
6	Hearing Impaired — Preschool Level	0
7	Hearing Impaired — Elementary Level	1
8	Hearing Impaired — Secondary Level	1
9	Educable Mentally Retarded — Elementary Level	0
10	Educable Mentally Retarded — Secondary Level	1
11	Trainable Mentally Retarded — Elementary Level	0
12	Trainable Mentally Retarded — Secondary Level	1
13	Emotionally Disturbed — Elementary Level	0
14	Emotionally Disturbed — Secondary Level	1
15	Special Learning Disabilities — Elementary Level	0
16	Speech Impaired — Elementary Level	0
17	Speech Impaired — Secondary Level	1
18	Physically Handicapped — Elementary Level	0
19	Physically Handicapped — Secondary Level	1

- Chronological age of the lowest age level in each target group (e.g., 6 for blind children at elementary school level).
- A set of indicators used by the REQMODEL program to determine which target groups, adjacent in the list, are defined as representing the same handicapping condition (e.g., if TG_{10} represents the same handicapping condition as TG_9, then the indicator for TG_{10} should be set = 1; if TG_{10} and TG_9 do not represent the same handicapping condition, then the indicator for TG_{10} should be set = 0); examples are shown in Table 1.
- Maximum number of attrition categories used for any target group (maximum of 4).
- Identifying code number of the attrition category used to represent the reason "returned to normal education", if the category exists.
- Identifying code number of the attrition category used to represent the reason "mortality", if the category exists[1/].

b. Special education characteristics

- Number of different educational program categories (total number irrespective of target group) used during this application of the model (maximum of 6).
- Prose title of each educational program (e.g., Residential Special School).
- Number of different types of special education personnel used during this application of the model (maximum of 25).
- Prose title of each type of personnel (e.g., Teacher of the Emotionally Disturbed).

c. User options

- Number of years or time periods of projection desired (maximum of 10).

1/ No identification code number is required for any other attrition categories other than "returned to normal education" and "mortality."

- The option which indicates to the computer program whether the user elects to input a different set of program weights for each projection year desired or elects to input one set of program weights to be used for the duration of the projection (the indicator is set = 1 if the former option is selected, = 2 if the latter is selected) .
- The option which indicates to the computer program whether the user elects to input the projected general child population (by single year of age) for each projection year desired or elects to rely on the REQMODEL to project the general child population using a simple algorithm (the indicator is set =1 if the former option is selected, = 2 if the latter is selected).
- The option which indicates to the computer program whether or not the user wishes to suppress the printing of the detailed model output for all but the initial point in time and the final projection period (the indicator is set = 2 if this option is selected, = 1 if output for all projection periods is desired).

TARGET GROUP POPULATIONS

7.3 The number of children in each target group is the major data element in this set; the number must be subdivided by single year of age for each target group. A target group population, defined as the number of children identified as needing special education, contains two categories of children (each representing an educational service status). The first is the number of children actually enrolled in special education programs, and the second is the number of children on special education waiting lists, i.e., children who are identified as belonging in a target group but who are not receiving the special education services normally provided to that target group. The data for these two categories may be collected as separate data elements within a special education information system, but they must be combined into one data element (enrolled plus waiting list) for input into the REQMODEL program.

7.4 The user of the model has the option to include an estimate of the number of children who are believed to be handicapped in the definition of a target group. Doing so would make this data element value acceptable but would not make it scientifically accurate—i.e., empirical. Thus, it is recommended that only the known number of handicapped children be included in a target group definition. If estimates of the unidentified, or potential, target group population are included, the validity of the resulting manpower requirements, which should be based upon

an initial set of empirical data, cannot be demonstrated. However, if a state (or other political/educational subdivision) special education administrator lacks so much factual detail that he cannot even define a target group population empirically, he may want to use estimates of that population (perhaps based upon the prevalence rate for the particular handicap) rather than eliminate the target group from the model simulation entirely.

7.5 Caution must be observed if prevalence rates are to be used in any way. These rates are merely estimates, and the degree of refinement embodied in each estimate varies from state to state. Most of the rates that are currently used are in need of more refinement. Basically, there are two methods of refining or validating prevalence rates. The first requires a random sampling of about 1% (more in a less populous area) of the total child population in the political/educational area for which a set of prevalence rates is desired. All the children in the sample would then be diagnosed for possible handicapping conditions; the proportion of children diagnosed as having each handicap would constitute reliable estimates of the true prevalence rates. The second method assumes that the total identified target group population is approximately equal to the total target group population that actually exists. In this case, all children will have been diagnosed and the findings recorded. Thus, the prevalence rates so determined will be empirical data and, if they are by single year of age, can be used to calculate target group population input to the REQMODEL program. Such a condition may be most closely approximated in the blind handicapped group.

7.6 The other data element in this Target Group Population set is calculated or estimated by the user as the proportion of each target group population enrolled, or being served, in special education; termed participation rate by the model, this proportion is sometimes referred to as service level. This data element can be varied by the user in different applications of the model to produce a series of estimates of manpower requirements based upon different service level assumptions. In this way, the REQMODEL program can become a tool for special educators to simulate the effect of changes in the estimated service level—changes that could result from various funding levels and/or facility capacities.

TARGET GROUP ENTRANTS AND ATTRITIONS

7.7 These data elements are used to calculate the simulated movement of children into and out of each target group. The following paragraphs describe the specific data elements (not in the order of actual input) in this set which must be provided.

Entrants Rates

7.8 The model applies the new entrants rates of each target group, by single year of age, to the general child population to determine the number of children expected to enter each target group population during a particular time

period (usually 1 year). Thus, each rate represents the probability that a child of a particular age will enter the target group in the near future. The model uses the terminology "new entrants rates" rather than "new incidence rates" to emphasize that the values of this input data element should represent the proportion of children who will actually be diagnosed (medically and educationally) as belonging to a target group, not the proportion of children who develop a handicapping condition but are not formally identified through diagnosis. Consequently, the annual variations in the new entrants rates will be closely tied to actual diagnostic practices (e.g., number of diagnostic personnel available, amount of diagnosis being performed, and diagnostic technology) instead of to medical phenomena (e.g., epidemics), until such time as all possible handicapped children in the population have been diagnosed. These entrants rates may also be termed the "actual incidence rates" (the current rates at which children are newly diagnosed as needing special education) for each target group and will become the "true incidence rates" of a target group when the total identified target group population is approximately equal to the total target group population that actually exists. As the discussion concerning "prevalence rates" (paragraph 7.5), points out, this situation will be reached when all the children have been diagnosed.

7.9 The values of the new entrants rates should be based upon at least 4 or 5 years of empirical data about the number of children diagnosed. In this way, annual fluctuations will be averaged and, thus, the rates will be stabilized. The stabilized rates may then be updated using the diagnostic data for subsequent years. As is the case with the target group populations, the calculated manpower requirements will be more valid if the values of the new entrants rates are based upon actual data. If there are insufficient existing empirical data about the number of newly diagnosed children, the new entrants rates may be estimated by the model user until such data are available.

Attrition Rates

7.10 The model applies the attrition rates of each target group, by single year of age, to the population of that group to determine the number of children who are expected to leave the target group population during a particular time period (usually 1 year). Thus, each represents the probability that a child of a particular age will leave the target group in the near future. The user has the option of subdividing the total attrition rates of each target group into up to 4 categories, each representing a specific reason for attrition. Regardless of whether the attrition rates represent the total attrition or attrition by reason category, the total number of children leaving the target group must be accounted for—i.e., those attriting from either target group category, or enrolled, or waiting list. As with the new entrants rates, the results of the model projection will be more valid if the values of the attrition rates, either total or by reason category, are based upon actual data.

7.11 When collecting the raw data that are to be used to calculate the attrition rates, the model user or his data source should ensure that the raw

data elements include a provision for recording intrastate transfers. This intermediate data element is used to adjust the raw data collected for either total attritions or the "moved out of the school district" reason category. This adjustment is necessary to eliminate an overestimation of the actual attrition rates, caused by children who move from one school district to another within the state or political/educational subdivision; but, because they do not really leave the handicapped child population, they should not be classified as attritions. The calculation of the actual attrition rates can be expressed as [attritions for all reasons minus intrastate transfers] or as [attritions for all reasons other than "moved" plus ("moved" attritions minus intrastate transfers)].

7.12 The values of the attrition rates should be based upon at least 4 or 5 years of empirical data about the number of children leaving each target group (adjusted for intrastate transfer as described above). In this way, annual fluctuations will be averaged, and the rates stabilized. The stabilized rates may then be updated using the actual attrition data for subsequent years. If there are insufficient existing empirical data about the number of children that leave a target group, the attrition rates may be estimated by the model user until such data are available.

Technology and Policy Influences

7.13 The data elements representing these real-world influences are termed factors, or parameters, by the REQMODEL program. Their quantification and use ensure that the model's target group new entrants and attrition rates reflect the potentially significant influences of changes in certain technologies, practices, and policies that are not necessarily directed solely toward special education or the handicapped population.

7.14 There are two recommended methods for quantifying these factors. The first is analysis of a factor's components to enable an implicit, i.e., subjective, derivation of its value. The second is a comparison, over time, of at least two values of a model data element that is influenced only by the factor under consideration to enable an explicit quantification of the factor—as the average yearly proportional difference between the values of the data element. The following discussion explains the three groups of factors representing the external influences and goes into more detail about the recommended methods of their quantification.

7.15 Medical Technology Factors. These, one factor value for each target group defined, are used to simulate the effects on each target group population of changes in medical technology for that target group over time, as shown through changes in the values of certain other model data elements. The values of the factors represent the proportion of yearly change in the values of certain model data elements that is attributable to changes in medical technology and its implementation. The application of this factor to those model data elements results qualitatively in the changing of their values in proportion to the estimated factor value.

7.16 If an analysis of components is to be used to implicitly determine the value of the medical technology factors, those components considered must include (a) the number and types of medical advances or innovations presently being made, (b) the amount of research being supported to develop new medical advances, and (c) the rate at which these advances diffuse throughout the medical community and affect the handicapped populace.

7.17 The model assumes that changes in new entrants rates (data elements discussed previously) are due in part to changes in medical technology—i.e., that fewer children will become handicapped or need special education as medical technology advances. Similarly, the model also assumes that changes in the attrition rates representing the reason "mortality" (if such a reason category is specifically defined by the model user) are due solely to changes in medical technology—i.e., that fewer handicapped children will die as medical technology advances. Finally, the model assumes that changes in the attrition rates representing the reason "returned to normal education" (if such a reason category is specifically defined by the model user) are due in part to changes in medical technology—i.e., that a greater number of children will be able to return to normal education as medical technology advances.

7.18 As an example of a specific assumption underlying the quantification of this factor, its value would be set at .01 if the user assumed that medical technology by itself would affect the relevant model data elements (in the way illustrated previously) at the rate of 1% per year. In other words, new entrants rates and "mortality" attrition rates would decrease 1% per year, and "return to normal education" attrition rates would increase 1% per year.

7.19 Educational Policy and/or Practice Factors. These, one factor value for each target group defined, are used to simulate the effects on each target group population of changes in educational policy and/or practice relating to that target group over time, as shown through changes in the values of certain other model data elements. The values of the factors represent the proportion of yearly change in the values of certain model data elements that is attributable to changes in policy and/or practice within special education.

7.20 As has been stated in the discussion of the medical technology factor (paragraphs 7.15 ff.), the application of this factor to those model data elements results quantitatively in the changing of their values in proportion to the estimated factor value. However, the numerical values of this factor are related to a more abstract notion than that of the technology factors: that of the expansiveness of the definition of the kinds of children who are eligible for special education—i.e., how broad the definition is of each target group. For example, if the policies and/or practices in effect at the initial point in time used during an application of the model are changed so as to encourage the retaining of mildly handicapped children in regular education, the value of this factor should be less than zero. Conversely, if the policies and/or practices are changed so as to encourage the placing of mildly handicapped children in target groups (e.g., a policy that would raise the upper limit I.Q. of the educable mentally retarded target group(s) from 70 to 75), the value of this factor should be set greater than zero.

7.21 Examples of components that must be considered if implicit quantification is to be used to determine the value of the educational policy and/or practice factors are (a) the number and planned effect of new policies on increasing or decreasing the rate of the return of children in special education to normal education, (b) the number and planned effect of new policies on decreasing the dropout rate, (c) the number and planned effect of new policies on increasing the number of children eligible for special education, and (d) the rate of implementation of policy changes.

7.22 The model assumes that changes in new entrants rates are due in part to changes in educational policy and/or practice—i.e., that more children will become eligible for special education as the value of the educational policy and/or practice factor increases (as the definition of a target group expands). The model assumes that changes in the attrition rates representing the reason "returned to normal education" (if such a reason category is specifically defined by the model user) are due in part to changes in educational policy and/or practice (the other partial influence was discussed above under the medical technology factor)—i.e., that a greater number of children will be returned to normal education as the value of the educational policy and/or practice factor decreases (as the definition of a target group narrows). Finally, the model assumes that changes in the total attrition rates, if the model user does not subdivide the attrition rates into reason categories, and changes in the attrition rates representing all other reason categories (e.g., moving out of the school district) are due solely to changes in educational policy and/or practice—i.e., that fewer children will move out of the district or, as discussed previously, will return to normal education as the value of educational policy and/or practice increases.

7.23 As an example of a specific assumption underlying the quantification of this factor, its value would be set at -.01 if the user assumed that educational policy and/or practice by itself would affect the relevant model data elements (in the ways illustrated previously) at the rate of -1% per year. In other words, new entrants rates would decrease 1% per year, and a "returned to normal education" or a "total" attrition rate would increase 1% per year.

7.24 Diagnostic Technology Factors. These, one factor value for each target group defined, are used to simulate the effects on each target group population of changes in diagnostic technology for that target group over time, as shown through changes in the values of one subset of other model data elements. The values of the factors represent the proportion of yearly change in the values of those model data elements that is attributable to changes in diagnostic technology or the level of diagnostic service relevant to the rate at which children enter (are diagnosed as belonging to) a target group. As in the discussions of the other two factors, the application of this diagnostic technology factor to those model data elements results quantitatively in the changing of their values in proportion to the estimated factor value.

7.25 When implicitly quantifying these factors, using an analysis of components, those considered must include (a) the number and types of new innovations in diagnostic technology, (b) the rate of implementation of these new innovations, (c) the amount of research being supported to develop new diagnostic technologies, (d) the number and capacity of new or expanded diagnostic services, and (e) the rate at which new diagnostic services are offered.

7.26 The model assumes that changes in new entrants rates are due in part to changes in diagnostic technology (as discussed previously, the other two partial influences are medical technology and educational policy and/or practice)—i.e., that more children will enter (or will be diagnosed as belonging to) a target group as the value of diagnostic technology for that target group increases.

7.27 As an example of a specific assumption underlying the quantification of this factor, its value would be set at .02 if the user assumed that diagnostic technology by itself would affect the relevant entrants rates (in the way illustrated above) in the amount of 2% per year. In other words, new entrants rates would increase 2% per year.

GENERAL CHILD POPULATION

7.28 The model uses the projections of the general child population, by single year of age, in conjunction with the new entrants rates previously discussed to calculate the number of children who are expected to enter each target group population during a particular projection period, usually 1 year. The first data element in this set is the current, or initial, number of children in existence; this number must be subdivided by single year of age. If the state or political/educational subdivision of the user has already prepared general child population projections (by chronological age or by narrow age ranges from which the individual age populations can be interpolated), then an element consisting of those projections for each year of model simulation desired is the only other data element in this set that is required by the model.

7.29 If the prepared general child population projections are not available to the user for model input, the remaining data elements in this set are used by the model to calculate those projections, by single year of age. The following paragraphs describe the specific remaining data elements (not in the order of actual input) which must be provided if the user chooses the option whereby the model calculates those projections.

Projected Total Population

7.30 The model uses the total number of people in the population at a given future point in time to calculate the expected number of births. Thus, the total population figure must be provided by the user for each projection period (usually 1 year) of model simulation specified by him.

Projected Birth Rates

7.31 The model uses these rates in conjunction with the corresponding total population figure to calculate the expected number of births, i.e., the number of children in the general child population of chronological age zero. Thus, an estimated birth rate must be provided by the user for each projection period of model simulation specified by him. As an example of a birth rate, if the number of live births per 100,000 persons is 19.2, the birth rate is .000192.

Survival Rates

7.32 The model applies the survival rates, by single year of age, to the calculated general child population, also be single year of age, in order to adjust that population for a mortality factor. The user may obtain these rates from standard life tables.

Medical Technology Influence

7.33 This data element represents the real-world influence of medical technology on the general child population survival rates over time. Thus, as was pointed out in the discussions of the three factors in the previous set of data elements, this factor is used by the model to simulate the effects on the general child population of changes in medical technology relevant to the general population over time, as shown through changes in the values of the survival rates. The value of the factor represents the yearly change in the values of the survival rates that is attributable to changes in medical technology. Quantitatively, the application of this factor to the survival rates results in the changing of their values in proportion to the estimated factor value. The model assumes that changes in the survival rates are directly proportional to the changes in medical technology implied by the factor value—i.e., that a greater number of children survive each year as medical technology advances.

7.34 The quantification of this factor can be accomplished by either of the two methods described in the discussion of outside influences in the previous set of data elements. If an analysis of components is to be used to implicitly determine the value of this medical technology factor, the three components considered must include (a) the number and types of medical advances or innovations presently being made, (b) the amount of research being supported to develop new medical advances, and (c) the rate at which these advances diffuse throughout the medical community and affect the general child populace. As an example of a specific assumption underlying the quantification of this factor, its value would be set at .001 if the user assumed that medical technology by itself would cause the survival rates to increase in the amount of 0.1% per year. Caution must be observed when setting the value of this factor; the factor should not cause the survival rates to increase past values of 1.0.

SPECIAL EDUCATION SIMULATORS

7.35 The data elements in this set are used by the model to simulate the conduct of special education services. They represent the user's assumptions regarding the proportion of each target group's enrolled population that will be served by each educational program, the types of personnel that will serve in each of these educational programs, and the number of personnel/pupil contacts of each personnel type serving in each educational program. The following paragraphs describe in more detail (not in the order of actual input) the specific data elements in this set which must be provided.

Program Mix

7.36 This consists of a set of educational program weights for each target group. The value of each educational program weight is the proportion of the associated target group's enrolled population that is being, will be, or is assumed to be served by a particular educational program. For example, if the user assumed that 25% of the special education enrollees of a target group of partially sighted children were going to be served in a resource room program, the value of that educational program weight would be .25. The only constraint placed on each set is that all of the educational program weights for a particular target group must add up to 1.0 (representing 100% of the target group's enrolled population).

7.37 The user has the option of inputting one set of values for program mix that will be applied by the model for all desired projection periods or of inputting a new set of values for program mix into the model for each projection period (usually 1 year). The latter is desirable only if the user is having the model print detailed output for each projection period and desires to inspect the resulting trend in manpower requirements. If the program mixes are inputted for each projection period, this data element becomes a continuing input. The future values of these educational program weights can be estimated on the basis of present trends in educating the handicapped child population or can be determined on the basis of subjective judgments regarding planned trends within special education.

Personnel/Pupil Contacts

7.38 For each type of personnel occupation serving each target group in each educational program, the number of personnel/pupil contacts (used by the model to calculate the personnel/pupil contact ratio) must be determined by the user. The number of personnel/pupil contacts is calculated as the number of children served by one person of that occupation type in that educational setting. These values are often termed "teacher/pupil loads." For example, for a person of an occupation type who serves 30 different children during a projection period (even though he serves only 10 at any one time), the user would input 30 as the number of personnel/pupil contacts.

7.39 These contacts may be determined on the basis of legislated, actual (the existing situation), or ideal (reflecting the situation in which all handicapped children would be served in an ideal way) personnel/pupil contacts. If the latter basis is used, the contacts will be determined subjectively.

Technology and Policy Influences

7.40 The data elements representing these real-world influences are termed factors by the REQMODEL program. Their quantification and use ensure that the model's personnel/pupil contact ratios (based upon the inputted personnel/pupil contacts) reflect the potentially significant influence of changes in certain technologies and policies that are directed toward special education. The two quantification methods discussed in paragraphs 7.7 ff., "Target Group Entrants and Attritions" for similar technology and policy influences are also recommended for these factors. The following paragraphs explain the two groups of factors representing the influences and give detailed discussion of the recommended methods of their quantification.

7.41 Educational Technology Factors. These, one factor value for each personnel type defined, are used to simulate the effects on each of the personnel/pupil contacts of changes in educational technology for that personnel type over time, as shown through changes in the values of the model's personnel input proportions for that personnel type. The values of the factors represent the proportion of yearly change in the values of the personnel input proportions that is attributable to changes in educational technology and its implementation. The application of this factor to those personnel input proportions results quantitatively in the changing of their values in proportion to the estimated factor value. If an analysis of components is to be used to implicitly determine the value of the educational technology factors, those components considered must include (a) the number and types of educational innovations presently being made, including new teaching methods as well as materials, (b) the amount of research being supported to develop new educational techniques and materials, and (c) the rate at which these innovations are being implemented in the special education classrooms.

7.42 The model assumes that changes in the personnel/pupil contacts are due in part to changes in educational technology—i.e., that a personnel type will be able to serve more children as educational technology advances.

7.43 As an example of a specific assumption underlying the quantification of this factor, its value would be set at .002 if the user assumed that educational technology by itself would cause the relevant personnel/pupil contacts to increase at the rate of 0.2% per year.

7.44 Personnel Input Policy and/or Practice Factors. These, one factor value for each personnel occupation type defined as serving in each educational program (regardless of target group served), are used by the model to simulate the effects on each of the personnel/pupil contacts of changes in personnel policy and/or practice relating to that personnel occupation type over time, as

shown through changes in the values of the model's personnel/pupil contact ratios for that personnel occupation type. The values of the factors represent the proportion of yearly change in the values of the personnel/pupil contacts that is attributable to changes in policy and/or practice relating to personnel employment within each special education program. The application of this factor to those personnel/pupil contacts results quantitatively in the changing of their values in proportion to the estimated factor value.

7.45 However, the numerical values of this factor are related to a more abstract notion than that of the technology factor: that of the policy or practice of assigning loads to each personnel occupation type—i.e., all other factors equal, that of creating a better educational environment. For example, if the policies and/or practices in effect at the initial point in time used during an application of the model are changed so as to encourage the lessening of a resource room personnel's pupil load, the value of this factor should be set greater than zero. Conversely, if the policies and/or practices are changed so as to encourage the increase in an itinerant personnel's pupil load, the value of this factor should be set less than zero.

7.46 Examples of components that must be considered if implicit quantification is to be used to determine the value of the personnel input policy and/or practice factors are (a) the number and planned effect of new policies that would increase or decrease the number of personnel/pupil contacts and (b) the rate of implementation of policy changes.

9.47 The model assumes that changes in the personnel/pupil contacts are due in part to changes in personnel input policy and/or practice—i.e., that a personnel occupation type employed in a particular educational program will be assigned a lower number of personnel/pupil contacts as personnel input policy and/or practice increases. As an example of a specific assumption underlying the quantification of this factor, its value would be set at .001 if the user assumed that personnel input policy and/or practice by itself would cause the relevant personnel/pupil contacts to decrease at the rate of 0.1% per year (and thus cause the corresponding personnel/pupil contact ratios to increase at the rate of 0.1% per year).

PREPARATION OF MODEL INPUT

7.48 This concludes the detailed discussion of the data elements that are required by the REQMODEL computer program. The actual order of input and the data input formats associated with each data element are contained in Part C of this report, Manpower Requirements Projection Model—Technical Documentation of the Computer Program. If the primary user is not familiar with the technical aspects of computer input preparation, he should arrange for the assistance of a technical representative (perhaps from the computer facility) who will take the responsibility of preparaing the input, submitting the REQMODEL program to be run, and returning the output to the user, according to the formats and procedures outlined in Part C of this report.

VIII. DESCRIPTION AND FORMAT OF MODEL OUTPUTS

8.1 The output of the Manpower Requirements Projection Model computer program consists of four sets of information, each printed in a different format. The REQMODEL program automatically prints the four sets of outputs for the initial starting point assumed by the user. Thereafter, the user has the option to obtain either (a) the four sets of outputs for each projection period defined for that application of the model or (b) the four sets of outputs for the final projection period only. In the following paragraphs, a description (accompanied by illustrative samples) of each set of model outputs and a discussion of their potential application are presented.

TARGET GROUP POPULATION, INITIAL OR PROJECTED

8.2 For each target group defined by the user in the model application, a page of output is printed, which contains the target group title and, for each chronological age, its population, the estimated number of attritions that will occur during the time period, the attrition rates (up to four) that were used, the number of new entrants during the previous time period, the new entrants rate that was used, and the number of new entrants that successfully completed the education program of the previous target group (if it represents a lower education level of the same handicapping condition) during the previous time period. Additionally, the related technology and policy factor values and information for the target group are printed at the bottom of the page; these are the target group indicator (to indicate if it represents a higher education level of the same handicapping condition as the previous target group), the medical technology factor value,[1/] the educational policy and/or practice factor value,[1/] the diagnostic technology factor value,[1/] and the target group's participation

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[1/] The printed value is equal to 1.0 + (the inputted factor value).

factor value (the proportion of children in the target group who are, or are assumed to be, enrolled in special education). A sample of this model output page is presented in Figure 5.

8.3 If the participation factor is less than 1.0, the projected target group population can be used by state special education administrators to support budgetary requests for additional funds. The number of children identified as needing but not receiving special education will be documented by this set of REQMODEL outputs. The attrition rates can be used to assist the administrators in evaluating aspects of their programs which affect attritions, and the new entrants rates can be used to assist both the diagnosticians and the special education administrators in evaluating the diagnostic program.

GENERAL CHILD POPULATION, INITIAL OR PROJECTED

8.4 The second set of outputs consists of one printed page containing the number of children of each chronological age (0-21) in the general child population. If the REQMODEL program projects this population, the output page also contains the survival rates associated with each age.

8.5 The output information in this set is only used to illustrate to the model user the basis for the calculations of the numbers of new entrants that were presented in the first set of outputs. Even if the model projects the general child population, the algorithm used for the calculations is not sophisticated enough to produce projections to the degree of validity which would be required for any other application. A sample of this model output page is presented in Figure 6.

SPECIAL EDUCATION SIMULATION ELEMENTS, INITIAL OR PROJECTED

8.6 For each target group defined by the user in the model application, a page of output is printed, containing the target group title, the educational program type definitions, the educational program weights, and a print line for each personnel type serving the target group. This latter print line contains the title of the personnel type, the number of personnel/pupil contacts for each educational program in which he is employed, and the weighted number of personnel/pupil contacts (weighted by the above-mentioned educational program weights). Due to space limitations on each page, the related technology and policy factor values for each personnel type are not printed. A sample of this model output page is presented in Figure 7.

8.7 As was the case with the general child populations, this set of output information is solely illustrative. The weighted personnel/pupil contact ratios [1 ÷ (personnel/pupil contacts)] are used by the model to calculate the manpower requirements.

MANPOWER REQUIREMENTS, INITIAL OR PROJECTED

8.8 The final set of outputs consists of one printed page. For each personnel occupation type defined by the user for the model application, a line of output is printed, containing the title of the personnel occupation type and the number required. A sample of this model output page is presented in Figure 8.

FOR TG (11) = AUDITORIALLY IMPAIRED - ELEMENTARY

AT TIME T = 4, THE VALUES OF THE INDEPENDENT VARIABLES ARE

COLUMN	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	AGE	NUMBER	ATTRITIONS	P (1)	P (2)	P (3)	ENTRANTS	LARGE E	COMPLETED PREV. TG LAST YR.
	7	33.52	7.51	.2040000	.0200000	0	12.60	.0006895	20.917
	8	32.93	7.11	.1510000	.0650000	0	7.26	.0003883	
	9	34.96	10.77	.2310000	.0770000	0	9.76	.0005366	
	10	24.85	7.63	.1940000	.1130000	0	4.53	.0002484	
	11	15.84	8.49	.1600000	.0600000	0	3.48	.0001918	
	12	20.53	10.04	.4000000	.0890000	0	6.23	.0003442	
	13	14.26	6.92	.3330000	.1520000	0	6.45	.0003660	
TOTAL		176.89	58.49				71.22		

Small E = 1.0000000
Medical Technology = 1.0000000
Education Policy/Practice = 1.0000000
Diagnostic Technology = 1.0000000
Participation Factor = 1.0000000

FIGURE 5. TARGET GROUP POPULATION

FOR THE GENERAL POPULATION AT TIME T = 4, THE CENSUS FIGURES ARE

AGE	NUMBER
0	0
1	0
2	0
3	0
4	17383.00
5	18288.00
6	18510.00
7	18859.00
8	19287.00
9	18770.00
10	18807.00
11	18723.00
12	18663.00
13	18176.00
14	18066.00
15	17669.00
16	17335.00
17	16697.00
18	16317.00
19	15891.00
20	16070.00
21	0

FIGURE 6. GENERAL CHILD POPULATION INFORMATION

AT TIME T = 4, THE VALUES OF THE T/P RELATED INDEPENDENT VARIABLES

FOR TG (11) = AUDITORIALLY IMPAIRED - ELEMENTARY ARE

PROGRAM TYPE DEFINITIONS - 1 = DAY SPECIAL CLASS

2 = DAY SPECIAL SPEC. INSTRU.

3 = COOPERATIVE SPEC. CLASS

4 = RESOURCE ROOM

5 = ITINERANT INSTRUCTION

	PROGRAM TYPE					WEIGHTED AVERAGE
	1	2	3	4	5	
WEIGHTS (PROPORTION OF CHILDREN IN EACH PROGRAM)	.5280000	0	0	0	.4720000	
PERSONNEL INPUT PROPORTION FOR -						
TEACHER OF DEAF - ELEMENTARY	7.000	0	0	0	0	13.258
ASSISTANT FOR DEAF - ELEMENTARY	21.000	0	0	0	0	39.773
HEARING CLINICIAN - ELEMENTARY	0	0	0	0	14.000	29.661

FIGURE 7. PROJECTED PERSONNEL INPUT PROPORTIONS

AT TIME T = 4, THE REQUIREMENTS ARE

PERSONNEL TYPE	NUMBER REQUIRED
TEACHER OF TMR - ELEMENTARY	18.22
TEACHER OF TMR - SECONDARY	8.04
AIDE FOR TMR	18.13
TEACHER OF EMR - ELEMENTARY	62.46
PHYSICAL ED. TEACHER OF ELEM. EMR	2.44
LANG. DEVEL. TEACHER OF ELEM. EMR	7.31
SPEECH THERAPIST	16.24
TEACHER OF EMR - SI - ELEMENTARY	2.59
ASSISTANT FOR EMR - SI	1.29
TEACHER OF EMR - SECONDARY	65.20
DRIVER ED. TEACHER OF SECON. EMR	6.14
VOC. HOME EC. TEACHER OF SECON. EMR	2.12
PHYSICAL ED. TEACHER OF SECON. EMR	2.83
INDUSTRIAL ED. TEACHER OF SECON. EMR	2.12
TEACHER OF O.H. - ELEMENTARY	10.34
TEACHER OF O.H. - SECONDARY	2.68
AIDE FOR O.H. - ELEMENTARY	7.91
AIDE FOR O.H. - SECONDARY	1.64
PHYS. THERAPIST FOR O.H. -	2.44
PHYS. THERAPIST FOR O.H. - SECON.	.33
OCCUP. THERAPIST FOR O.H. - ELEM.	2.74
OCCUP. THERAPIST FOR O.H. - SECON.	.29
TEACHER OF V.H. - ELEMENTARY	3.77
TEACHER OF V.H. - SECONDARY	2.29
TEACHER OF SPECIAL LEARNING DISABIL.	11.90
TEACHER OF AUD. IMP. - ELEM	13.34

FIGURE 8. PROJECTED MANPOWER REQUIREMENTS

8.9 These calculated manpower requirements can be used by special education administrators to plan recruitment and budgeting of the needed personnel. Additionally, these requirements will provide educators, specifically special education teacher trainers, with estimates of the number and types of personnel which they must try to supply.

IX. MODEL APPLICATION

INTRODUCTION

9.1 Preceding sections of this part have presented to the model user background information about the model formulation and the required input data elements; this section describes possible types and levels of model application and the operational procedures for using the Manpower Requirements Projection Model (MRPM).

TYPES OF APPLICATIONS

9.2 As discussed previously, the MRPM was originally developed to enable Federal and state sponsors of special education personnel training to plan their programs to provide for the estimated number of personnel (by occupation type) needed to serve the handicapped child population. Unless these estimated numbers are based upon the total identified handicapped child population, the true manpower requirement calculations will be underestimated, and planning based upon those calculations will tend to perpetuate a shortage of manpower supplies. Thus, when applying the model to project the manpower requirements for planning purposes, the user should make every effort to ensure that target group data are complete—i.e., that handicapped children on special education waiting lists and those being served in private or other state agency (Health, Mental Hygiene, etc.) programs are included in the count of each target group's population. Such an effort will almost certainly include the development of interagency cooperation for the collection and reporting of these data.

9.3 However, until such time as interagency cooperation is a reality, a user may wish to apply the MRPM solely to project that part of the handicapped child population and manpower requirements associated with local public special

education programs. These projections could be used in planning budget and personnel hiring procedures. However, the user must be aware that, since the target group and manpower projections do not represent the totals for his state or political/educational subdivision, they can be used only as general guidelines by special education personnel trainers, and that other agencies and private sources will be competing in the hiring of special education personnel from the available manpower supply.

9.4 Using either of the abovementioned situations regarding the completeness of the target group data, the MRPM may be applied to test the effect of various assumptions on the projected manpower requirements. This type of application is very useful to a special education administrator who is responsible for the development and implementation of policies relating to the planning and operation of special education programs. Examples of this type of application are given below.

- Having generated the projected manpower requirements on the basis of current policy regarding personnel/pupil contact ratios, an administrator may wish to compare these with projected manpower requirements based upon different personnel/pupil contact ratios. For instance, he may change the ratio of a Teacher of the Emotionally Disturbed employed in a cooperative class educational program from 1/16 to 1/20. This comparison of requirements and other operational considerations will aid him in deciding whether, and how, to change the policy regarding these ratios.

- Having generated the projected manpower requirements on the basis of the currently existing educational program mix, an administrator may wish to compare these with projected manpower requirements based upon hypothetical educational program mixes. For instance, he may estimate that in 5 years the educational program mix of the Special Learning Disabilities—Ungraded target group will change from [30% in day special classes + 70% receiving itinerant instruation] to [25% in day special classes + 75% receiving itinerant instruction]. This comparison of requirements and other operational considerations will aid him in deciding whether, and how, to encourage the practice of placing a greater proportion of these children in itinerant educational programs.

USE OF FACTORS

9.5 As previously discussed, the MRPM includes provisions for the user to simulate the effects over time of real-world influences on certain model data

elements. The model formulation includes factors representing medical technology, educational policy and/or practice, diagnostic technology, educational technology, and personnel input policy and/or practice. The quantification of these factors may be difficult at first, but their use will increase the validity of the resulting projections of the handicapped child population and the manpower requirements.

9.6 It should not be inferred, however, that the model user must use all of these factors. As defined previously, a factor value represents the assumed proportion of yearly change in the value of a data element due to a certain real-world influence. It follows that, within the model, an inputted factor value of zero implies that the factor is assumed to have no effect on the calculations. Thus, for each factor that the model user wishes to exclude, he may input a factor value of zero into the model.

9.7 It is strongly suggested, however, that the MRPM user include the diagnostic technology factor in each model application; the rationale behind this suggestion originates from the fact that, at the present time, the number of children entering the handicapped child population of a state or political/educational subdivision is very closely tied to, if not completely dependent upon, the existing diagnostic system of the state or subdivision. If the target group definitions remain unchanged, it is not likely that this fact will change in the near future, because all indications are that the undiagnosed handicapped child population is large. For example, an increase in the number and/or size of diagnostic facilities will directly and significantly affect the set of new entrants rates associated with most of the target groups. This effect will be most pronounced on the new entrants rates of target groups whose characteristics are not easily recognizable to the layman, e.g., mildly emotionally disturbed, hard of hearing, and special learning disabilities.

TIME FRAME OF INPUT DATA

9.8 The reporting cycle for the information used to prepare the input data for the MRPM is very important to the validity of the resulting manpower estimates. Most obvious is that the most current information should be used. The required input data is based upon two categories of information: (a) information that represents the situation at a point in time and (b) information that represents events during a time period.

9.9 The target group populations (enrollments and waiting list), the general child populations, and the special education simulators are the input data elements that represent a point in time. Thus, concerning a data time period (e.g., 1 year), information needed to prepare these input data elements should be reported and processed as of the beginning of the time period. For example, using an October 1-September 30 data time period, target group populations, etc., should be reported as of October 1 each year. Since this information category is the basis of the model calculations, the MRPM output will contain the data projections as of the beginnings of future time periods. Thus, given the

example above, the model would estimate the beginning of school year target group populations and manpower requirements for future time periods. Similarly, using a July 1-June 30 data time period, the model would estimate the end of school year target group populations and manpower requirements for future time periods; slight interpolation of the data would then be required to estimate figures for the beginning of the next school year.

9.10 The second category of information contains items needed to calculate the new entrants and attrition rates; i.e., the numbers of new entrants (newly diagnosed), intrastate transfers, and attritions (subdivided by reason category if desired) that occurred during an entire data time period. Thus, these items should be reported and processed at the end of the time period. The user of the model would then be able to calculate the entrants and attrition rates for the time period in the following manner:

(a) new entrants rate = [Number of children having chronological age g who are newly diagnosed during a time period as needing special education] ÷ [Number of children having chronological age g in the general child population as of the beginning of that same time period]

(b) attrition rate = [Number of children having chronological age g who attrite from a target group for a particular reason (adjusted for intra-state transfers if necessary) during a time period.] ÷ [Number of children having chronological age g in the target group population as of the beginning of the time period.]

An entrants or attrition rate that is used as a model input data element should be based upon the corresponding individual rate for at least four different time periods. The averaging of these individual rates over time will stabilize the values of the model's input rates and increase the validity of the model calculations and projections.

OPERATIONAL PROCEDURES FOR MODEL APPLICATION

9.11 When the yearly information base is available to prepare the model input data elements, the user of the model should apply it at least once with operationally meaningful values of the special education simulation data elements to project the handicapped child population and manpower requirements. The number of subsequent model applications needed per year depends upon the number of assumptions (regarding service levels, educational program mixes, and/or personnel/pupil contacts) that the user wishes to test for their effects on the manpower requirements.

9.12 Unless the user of the model is intimately familiar with the technical aspects of setting up a computer run (e.g., coding the data for keypunching, assembling the keypunched data into the correct card sequence, etc.), he should arrange for technical liaison assistance to set up the MRPM program and data for a computer run. The person responsible for these technical aspects should read and follow the detailed instructions and card formats contained in Part C of this report, "Manpower Requirements Projection Model—Technical Documentation of the Computer Program."

9.13 Whenever a model application is desired, the input data should be given to the technical liaison in a clear, understandable format. To assist the user with this task, three forms (the first in two parts) have been designed, which contain spaces for the entry of all the input data elements required by the MRPM.

9.14 Forms 1A and 1B, shown on pages B-58-B-59, are used to record all of the data for a target group (Form 1A) and the portion of the special education simulation data that is oriented toward a target group (Form 1B). Data for each target group should be recorded on separate copies of Form 1 with the exact prose title of the target group printed in the space provided at the top of each part of the form. Figures 9 and 10 contain examples of completed Forms 1A and 1B. To avoid confusion when compieting both parts of the form, the row and column headings (i.e., educational program titles, chronological ages, attrition reason category titles, and occupation titles) should be entered first. The second group of data to be entered is the target group population, by age and educational level for the children enrolled in special education and by age for the children on the special education waiting list and the total target group population. In the completed example of Form 1A, since the Special Learning Disabilities target group is served by only two out of the six educational programs specified by the user, data are only entered in the two applicable rows. Although the technical liaison only requires the total target group population figures, the form's separation into enrolled and waiting list categories will assist the model user in "picturing" his input data and in determining the existing or desired educational program mix for entry into the rightmost column. The new entrants rates (rates at which children are diagnosed as needing special education) and the attrition rates (by reason category) are entered at the bottom of Form 1A.

9.15 For each occupation type utilized within each educational program serving the target group, the number of personnel/pupil contacts are entered in the appropriate portion of Form 1B. The "Educational Program Mix" portion of the form should be completed if the model user wishes to input a mix for each projection period being simulated by the MRPM. At the bottom of this form are spaces for the participation factor and the factors representing real-world influences—medical technology, educational policy and/or practice, and diagnostic technology.

TARGET GROUP DATA

Target Group Title:

		Educational Programs	Chronological Age									Educ.* Prog. Mix
Identified Handicap Child Population	Enrolled Population											
		Waiting List Population										
		Total Population										
New Entrants Rate												
Attrition Rates		Reason Category:										
		Reason Category:										
		Reason Category:										
		Reason Category:										

* Enter also in Form 1B

Form 1A

TARGET GROUP DATA

Target Group Title:

Educational Program Titles	Personnel/Pupil Contacts					Educational Program Mix										
	Occ. Type	Occ. Type	Occ. Type	Occ. Type	Occ. Type	Initial* Period	Projection Period									
							1	2	3	4	5	6	7	8	9	10

* Data are the same as recorded in the Educational Program Mix column in Form 1. Use of Projection Period Mixes is necessary only if a change in mix over time is anticipated.

MEDICAL TECHNOLOGY FACTOR =

EDUCATIONAL POLICY AND/OR PRACTICE FACTOR =

DIAGNOSTIC TECHNOLOGY FACTOR =

PARTICIPATION FACTOR =

TARGET GROUP INDICATOR =

Form 1B

TARGET GROUP DATA

Target Group Title: SPECIAL LEARNING DISABILITIES — UNGRADED

	Educational Programs	Chronological Age 6	7	8	9	10	11	12	13		Educ.* Prog. Mix
Identified Handicap Child Population / Enrolled Population	RESIDENTIAL SCHOOL										
	SPECIAL DAY SCHOOL										
	DAY SPECIAL CLASS	5	13	15	10	9	4	2	0		0.3
	COOPERATIVE CLASS										
	RESOURCE ROOM										
	ITINERANT INSTRUCTION		11	15	31	24	17	9	2		0.7
	Waiting List Population	9	23	41	46	39	28	10	4		
	Total Population	14	39	71	87	72	49	21	6		
New Entrants Rate		.0002604	.0007492	.0006528	.0005946	.0001709	.0000885	.0000449	.0000152		
Attrition Rates	Reason Category: RETURN TO NORMAL EDUCATION	.231	.105	.135	.089	.200	.188	.620	.790		
	Reason Category: OTHER	.077	.053	.058	.014	.075	.063	.202	.210		
	Reason Category:										
	Reason Category:										

* Enter also in Form 1B

Form 1A

FIGURE 9. COMPLETED EXAMPLE OF FORM 1A

TARGET GROUP DATA

Target Group Title: SPECIAL LEARNING DISABILITIES – UNGRADED

Educational Program Titles	Personnel/Pupil Contacts					Educational Program Mix										
	Occ. Type	Occ. Type	Occ. Type	Occ. Type	Occ. Type	Initial* Period	Projection Period									
	TEACHER FOR CHILDREN WITH S.L.D.	ASSISTANT FOR CHILDREN WITH S.L.D.	SOCIAL WORKER				1	2	3	4	5	6	7	8	9	10
RESIDENTIAL SCHOOL																
SPECIAL DAY SCHOOL																
DAY SPECIAL CLASS	8	16	45			0.3	0.3	0.3	0.27	0.27	0.25					
COOPERATIVE CLASS																
RESOURCE [illegible]																
ITINERANT [illegible]TION	22					0.7	0.7	0.7	0.73	0.73	0.75					

* Data are the same as recorded in the Educational Program Mix column in Form 1. Use of Projection Period Mixes is necessary only if a change in mix over time is anticipated.

MEDICAL TECHNOLOGY FACTOR = .0002

EDUCATIONAL POLICY AND/OR PRACTICE FACTOR = 0.0

TARGET GROUP INDICATOR = 0

DIAGNOSTIC TECHNOLOGY FACTOR = .002

PARTICIPATION FACTOR = .45

Form 1B

FIGURE 10. EXAMPLE OF COMPLETED FORM 1B

9.16 Form 2, shown on page B-63, is used to record all of the general child population data needed for the MRPM application. As noted at the bottom of this form, the data elements that must be entered depend upon which option the user elects regarding the projection of the general child population. The first column, the number of children in the general child population having each chronological age (0-21) as of the beginning of the initial time period, is required for both options. If the model user elects to input the projections, the data (by single year of age and individual projection period) should be entered in the columns marked as group 2. If the model user elects to have the MRPM calculate the projected general child population, the data required are the survival rates, by single year of age (in the rightmost column marked as 3), the total number of persons in the general population, for the initial and each projection period (in the first of two rows marked as group 4), and the birth rate of the general population, for the initial and each projection period (in the second of two rows marked as group 4). Figure 11 contains a completed example of this form; in this example the user elected to have the MRPM calculate the projections.

9.17 Form 3, shown on page B-65, is designed to record the remainder of the special education simulation data—the factors representing real-world influences on the number of personnel/pupil contacts. To avoid confusion when completing the form, the prose title of each occupation type included in the model application should be entered first. Then the values of the educational technology factor and the personnel input policy and/or practice factors[1/] (one for each educational program in which the personnel is employed) associated with each personnel occupation type should be recorded. A completed example of this form is presented in Figure 12.

9.18 These completed forms should be given to the technical liaison for card input formatting according to the MRPM technical documentation referred to in paragraph 9.12.

[1/] Not to be confused with the previously mentioned educational policy and/or practice factor entered on Form 1B.

GENERAL CHILD POPULATION DATA

Age	1 Initial Period	2 Projection Periods 1	2	3	4	5	6	7	8	9	10	3 Survival Rates
0												
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												
16												
17												
18												
19												
20												
21												
4 Total Population												
4 Birth Rate												

MEDICAL TECHNOLOGY FACTOR =

DATA NEEDED = COLUMN 1 + COLUMNS IN 2

COLUMN 1 + COLUMN 3 + ROWS IN 4

Form 2

GENERAL CHILD POPULATION DATA

Age	1 Initial Period	2 Projection Periods 1	2	3	4	5	6	7	8	9	10	3 Survival Rates
0	17357											.9996
1	17322											.9995
2	17343											.9995
3	17354											.9994
4	17383											.9994
5	18288											.9994
6	18510											.9994
7	18859											.9993
8	19287											.9993
9	18770											.9992
10	18807											.9992
11	18723											.9992
12	18663											.9991
13	18176											.9991
14	18066											.9991
15	17669											.9991
16	17335											.9991
17	16697											.9990
18	16317											.9990
19	15891											.9989
20	16070											.9987
21	15943											.9985
4 Total Population	722000	723,000	722800	722750	721900	722100						
4 Birth Rate	.0244	.0242	.0240	.0236	.0228	.0227						

MEDICAL TECHNOLOGY FACTOR = .00001

DATA NEEDED = COLUMN 1 + COLUMNS IN 2

COLUMN 1 + COLUMN 3 + ROWS IN 4

Form 2

FIGURE 11. EXAMPLE OF COMPLETED FORM 2

Occupation Type Title	Educational Technology Factor	Personnel Input Policy and/or Practice Factors					
		Educ. Prog.:	Educ. Prog.:	Educ. Prog.:	Educ. Prog.:	Educ. Prog.:	Educ. Prog.:
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							

Form 3

Occupation Type Title	Educational Technology Factor	Personnel Input Policy and/or Practice Factors					
		Educ. Prog.: RESID. SCHOOL	Educ. Prog.: SPEC. SCHOOL	Educ. Prog.: DAY SPEC. CLASS	Educ. Prog.: COOP. CLASS	Educ. Prog.: RESOURCE ROOM	Educ. Prog.: ITIN. INSTRU.
1 TEACHER OF VISUALLY HANDICAPPED	.0005	.0013	.0015	.0018	—	.002	.0025
2 TEACHER OF THE DEAF	.0008	.002	.0022	.0025	—	—	—
3 TEACHER OF THE EMR	.0004	.001	0	0	.002	—	—
4							
5							
6 (ETC.)							
7							
8							
9							
10							
11 TEACHER FOR CHILDREN WITH S.L.D.	.001	—	—	.002	—	—	-.0005
12 ASSISTANT FOR CHILDREN WITH S.L.D.	.001	—	—	.002	—	—	—
13 SOCIAL WORKER	0	—	—	-.001	—	—	—
14							
15							
16							
17							
18 (ETC.)							
19							
20							
21							
22							
23							
24							
25							

Form 3

FIGURE 12. COMPLETED EXAMPLE OF FORM 3

TECHNICAL REPORT 602
PART C

OPERATIONS RESEARCH, Inc.

SILVER SPRING, MARYLAND

STUDY OF THE NEED FOR EDUCATIONAL MANPOWER FOR HANDICAPPED CHILDREN AND YOUTH— PHASE III REPORT

PART C—MANPOWER REQUIREMENTS PROJECTION MODEL— TECHNICAL DOCUMENTATION OF THE COMPUTER PROGRAM

1 May 1970

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R. D. Mintz, Program Director, who was responsible for the overall technical direction and management of the project team;

C. M. Koch, Project Manager, who was responsible for the day-to-day direction of the project team, and who participated in the state survey analysis and co-author of the Phase III Report;

B. A. Johns, Assistant Project Manager, who was responsible for the design of the Manpower Requirements Projection Model, participated in the state survey analysis, and co-authored the Phase III Report; and

M. W. Brown, T. R. Jungreis, J. E. Kelly, J. J. Koshel, J.O'Donnell, and J. Peterson, state survey analysts.

PREFACE

The "Study of the Need for Educational Manpower for Handicapped Children and Youth—Phase III Report" has been organized so that appropriate parts of it may be conveniently distributed to those most immediately concerned with the content of each part. The general content of each part is as follows:

- Part A, Phase III Final Report, contains the overall report on the Manpower Requirements Projection Model (MRPM) validation efforts and the activities, findings, and conclusions of the state survey. Its appendices also contain implementation cost estimates and summaries of the enrollment and employment data collected during the state survey.

- Part B, Special Education Staff Users' Guide, contains both the general and the detailed guidance necessary for non-technical oriented personnel for understanding and implementation of the MRPM.

- Part C, Manpower Requirements Projection Model—Technical Documentation of the Computer Program, which is written for the technically oriented user of the MRPM, provides the technical details necessary for understanding the model formulations and computer programs.

- Part D, State Analysis Reports, includes individual reports on each state's special education information flow.

Parts B and C are bound together in one volume; Part D is divided into three volumes for ease in handling.

PART C

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PART C

MANPOWER REQUIREMENTS PROJECTION MODEL - TECHNICAL DOCUMENTATION OF THE COMPUTER PROGRAM

This document, written for the technically oriented user of the Manpower Requirements Projection Model, provides the technical details necessary to an understanding of the model formulations and the related parts of the computer programs. The sections contained in this Part, with the exception of Section I, correspond in number to the items of documentation prescribed in the HEW "Data Management Center Computer User's Guide," paragraph 2.3.2, Elements of Documentation.

I. INTRODUCTION

The Manpower Requirements Projection Model was developed to enable state or local level administrators of special education to estimate their manpower requirements and handicapped child population. The Bureau of Education for the Handicapped sponsored the development of the model to give the state divisions of special education an analytical tool to perform the estimates, to simulate effects of policy changes for planning purposes, and to encourage the states to upgrade their special education information gathering and handling procedures. The Bureau, while actively encouraging special education information system development and model application, emphasizes that the states must move forward voluntarily toward the use of these technological tools.

II. GENERAL INFORMATION

A. The program, entitled the Manpower Requirements Projection Model Program (REQMODEL), is written in the FORTRAN IV programming language for use on any computer configuration having a FORTRAN IV compiler and at least 32k words

of core storage. The Model Program is to be used on an "as required" basis, and a 10-year projection will run in an elapsed time of approximately 15 minutes on a hardware system equipped with both a high-speed card reader and printer. The Model was designed primarily for use at the state level for program planning purposes.

B. There are three general categories of inputs required for REQMODEL: projection input parameters, rates of movement, and policy variables/factors. Data in the first category, which include special education enrollment and waiting list data, originate from a special education information system. Data in the second category, which include new entrants and attrition rates from the handicapped child population, are computed from several years of data that originate from a special education information system. Data in the third category, which include special education policy information and factors representing real-world influences, originate from experts in the appropriate field, mostly in the field of special education.

If the Model Program is run at the Federal level, a copy of the output should be sent to the requester of the run. If the requester is not a member of the BEH staff, additional copies of the output should be sent to the Training Branch and the Program Planning and Evaluation Branch of BEH. If REQMODEL is run at the state level, copies of the output should be sent to the requester of the run, to the Director of the Division of Special Education (or the equivalents), and, on a voluntary basis, to the Division of Training Programs, Bureau of Education for the Handicapped (BEH-OE, HEW) in Washington, D.C.

As of April 1, 1970, REQMODEL has been tested and is error free. Further discussion of program tests is presented in Section XIII, Testing Information.

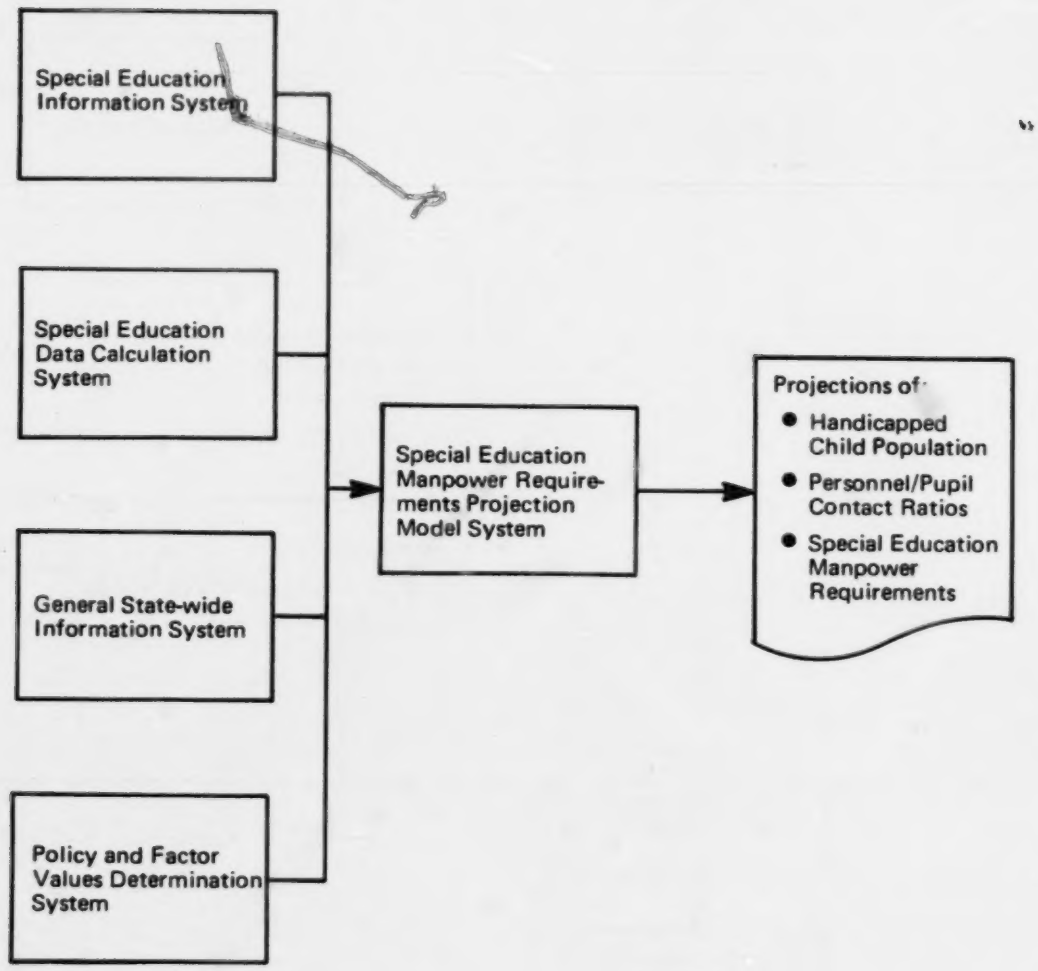
III. PROGRAM RESUME

A. The purpose of the REQMODEL program is to enable the user to project the handicapped child population, the special education personnel/pupil contact ratios, and the resulting special education personnel requirements, by type, up to 10 years in the future.

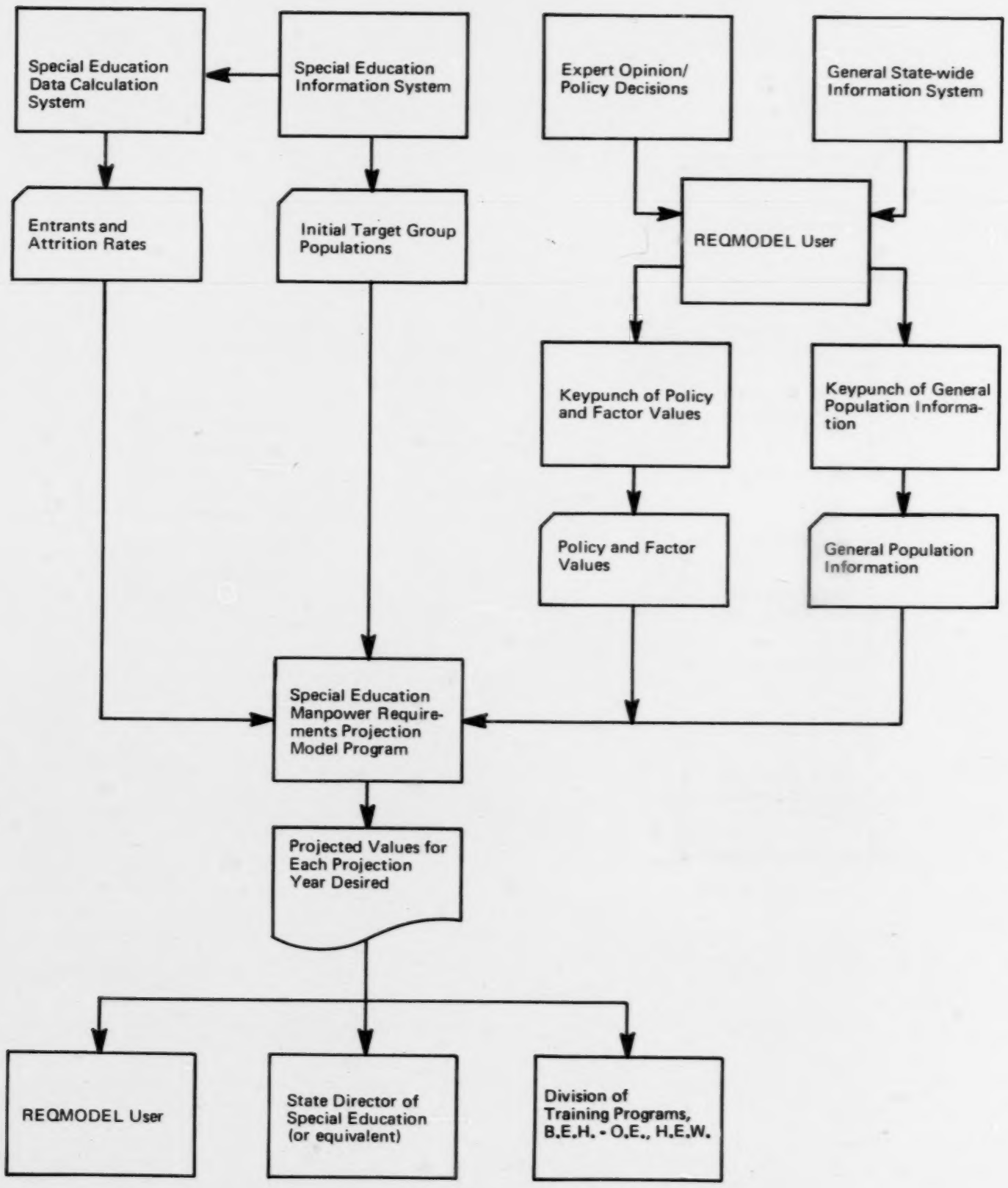
B. The mathematical formulation of the Special Education Manpower Requirements Projection Model is iterative. For each year of projection desired by the user, the REQMODEL program calculates the target group populations (from the previous year's populations, minus attritions and plus entrants), the personnel/pupil contact ratios (from the previous year's ratios, adjusted for external factors, and projected program weights), and the resulting personnel requirements (from the target group populations, adjusted for participation in special education, and the personnel/pupil contact ratios).

IV. PROGRAM LOGIC FLOW DIAGRAMS

A. System Flow

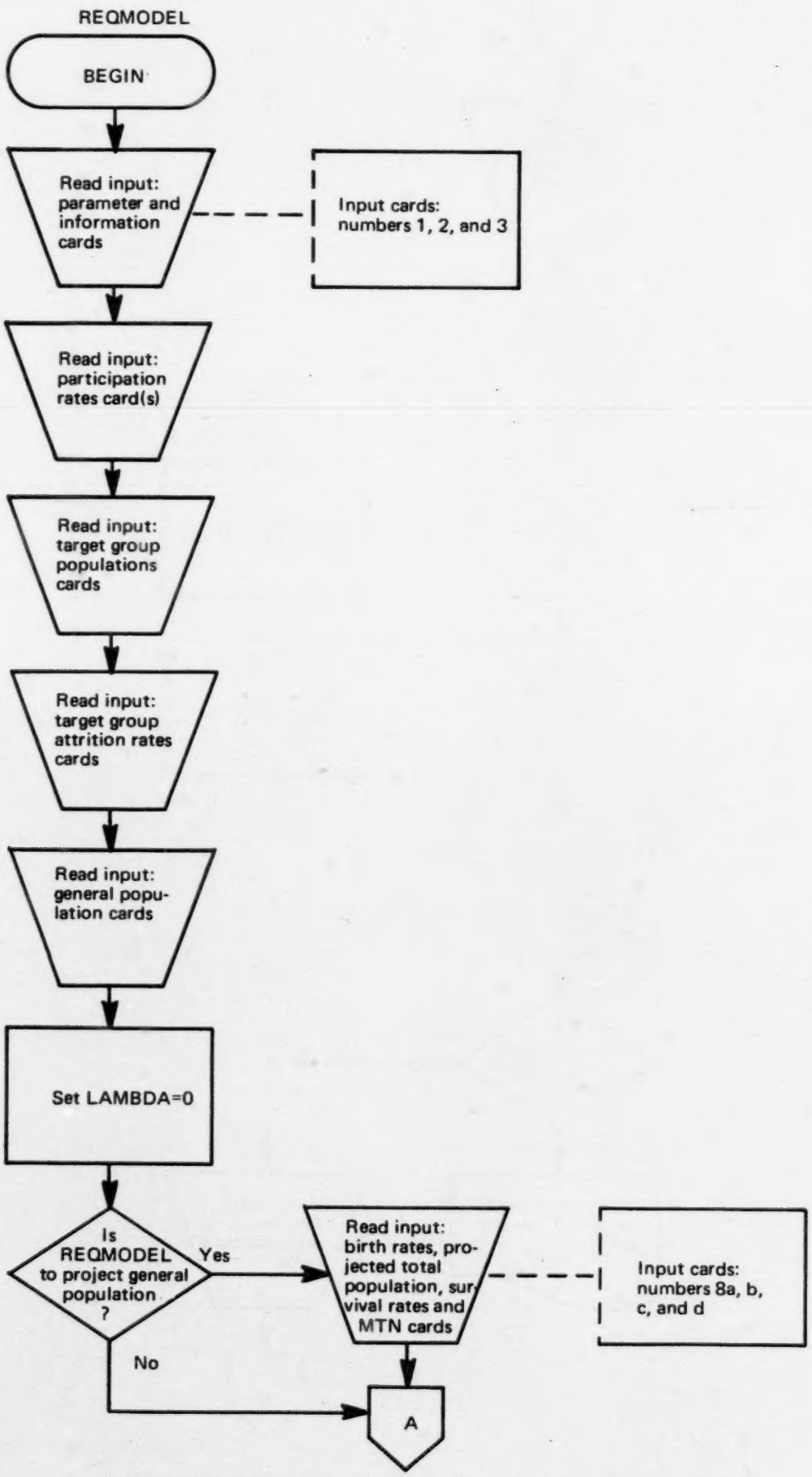

Special Education Information System
Special Education Data Calculation System
General State-wide Information System
Policy and Factor Values Determination System
Special Education Manpower Requirements Projection Model System
Projections of:
• Handicapped Child Population
• Personnel/Pupil Contact Ratios
• Special Education Manpower Requirements

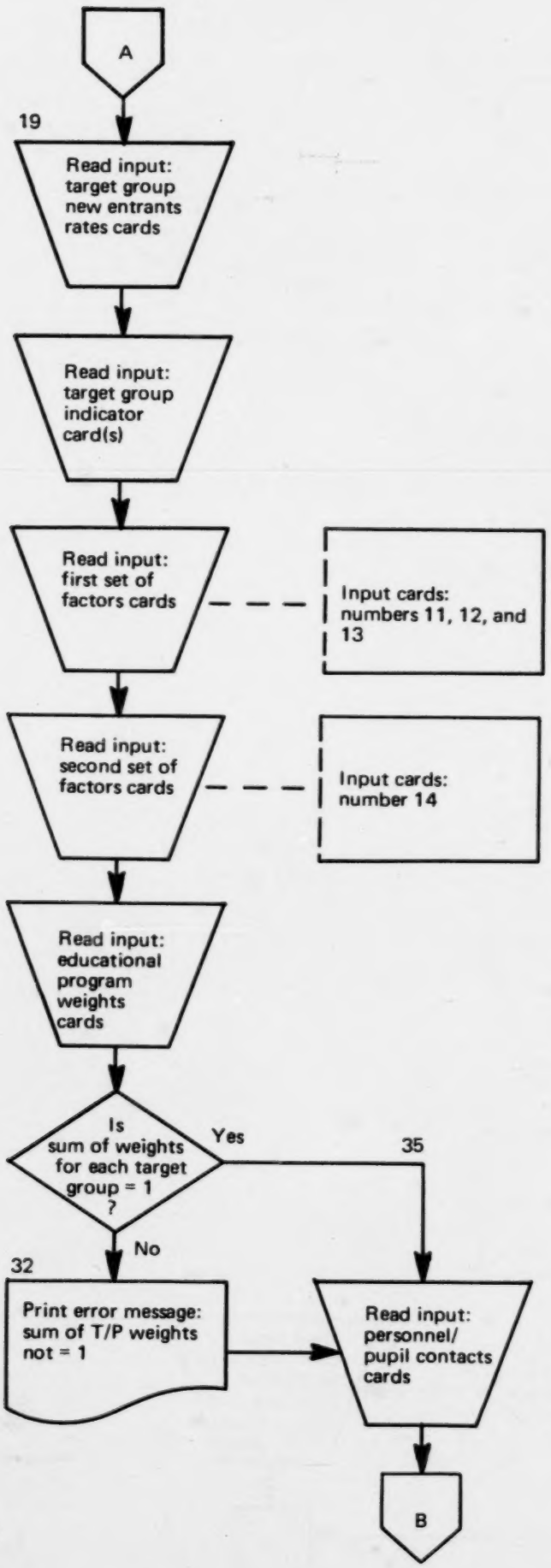
B. Input/Output Flow


Special Education Data Calculation System
Special Education Information System
Expert Opinion/ Policy Decisions
General State-wide Information System
Entrants and Attrition Rates
Initial Target Group Populations
REQMODEL User
Keypunch of Policy and Factor Values
Keypunch of General Population Information
Policy and Factor Values
General Population Information
Special Education Manpower Requirements Projection Model Program
Projected Values for Each Projection Year Desired
REQMODEL User
State Director of Special Education (or equivalent)
Division of Training Programs, B.E.H. - O.E., H.E.W.

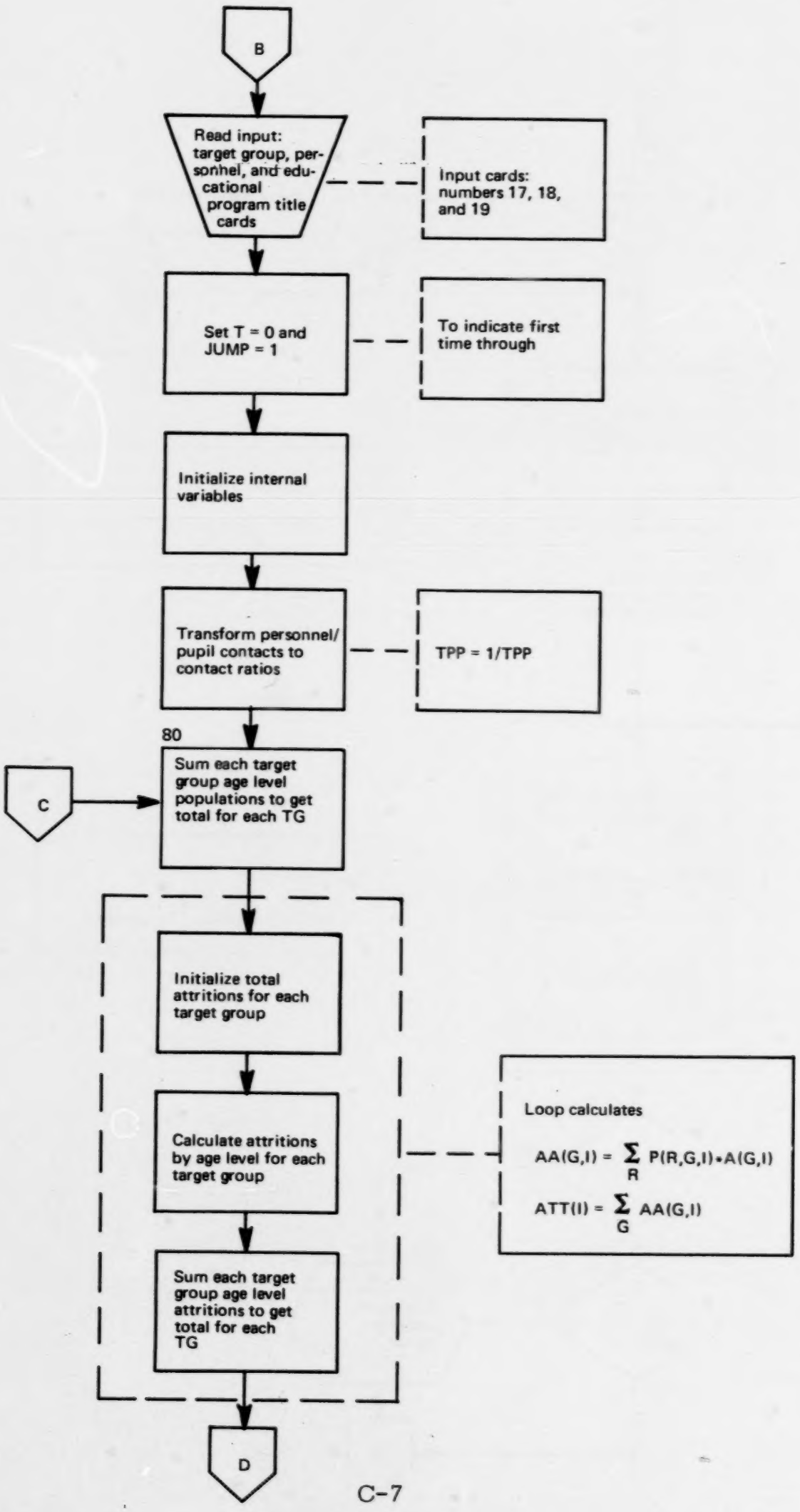
C. Program Flow

1. Main program—REQMODEL

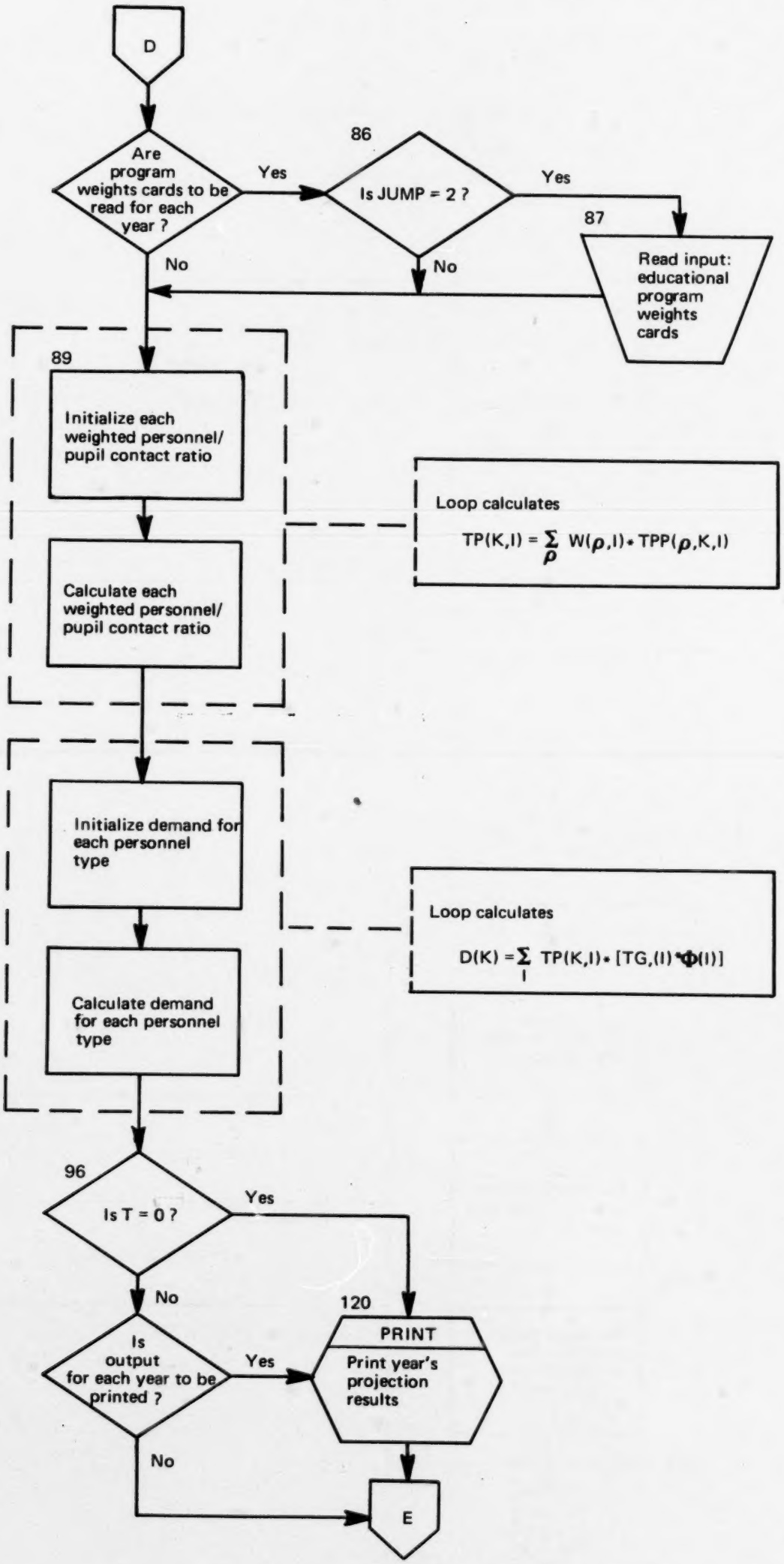

REQMODEL
BEGIN
Read input: parameter and information cards
Input cards: numbers 1, 2, and 3
Read input: participation rates card(s)
Read input: target group populations cards
Read input: target group attrition rates cards
Read input: general population cards
Set LAMBDA=0
Is REQMODEL to project general population ?
Yes
No
Read input: birth rates, projected total population, survival rates and MTN cards
Input cards: numbers 8a, b, c, and d
A

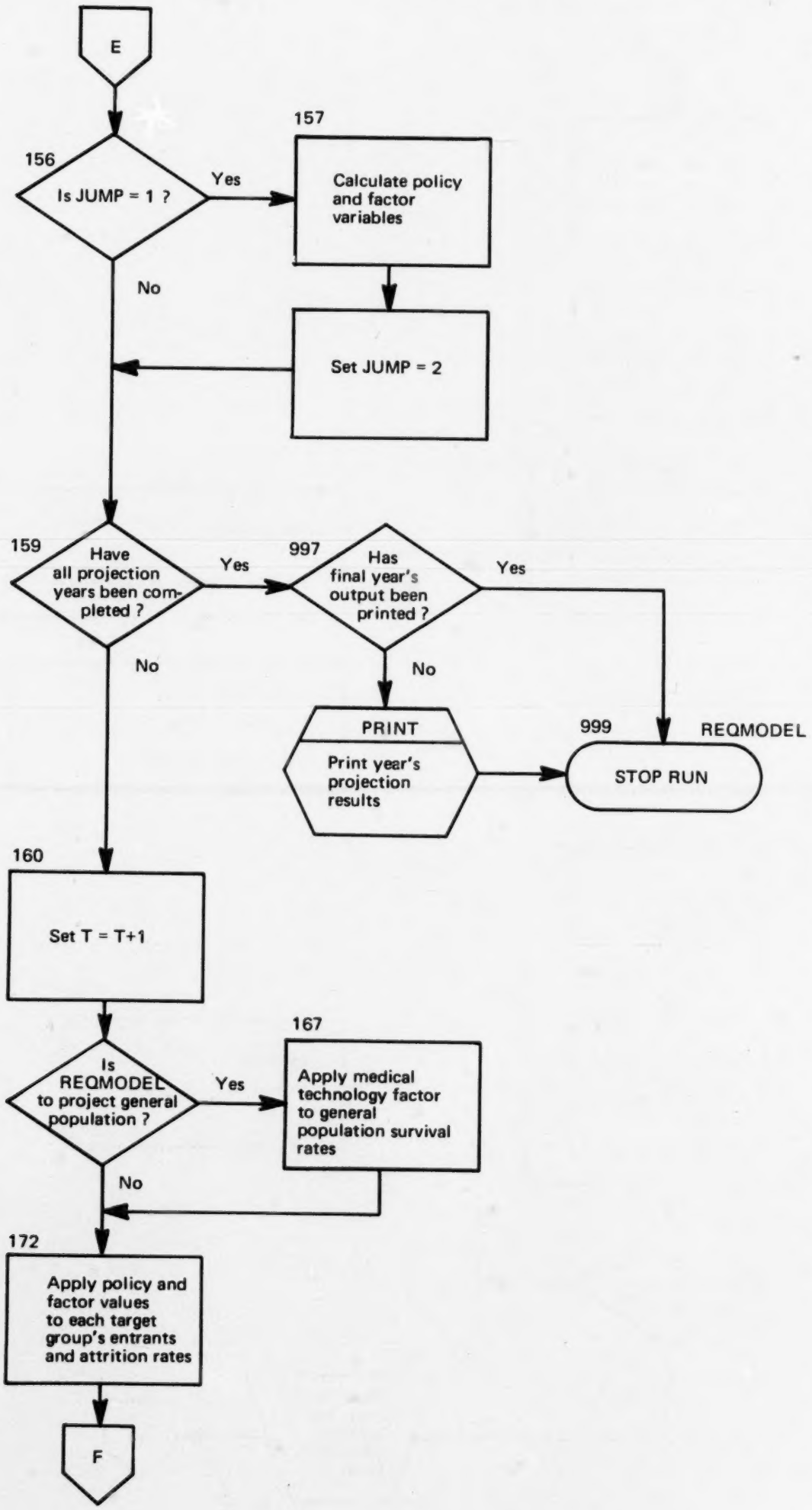

A
19
Read input: target group new entrants rates cards
Read input: target group indicator card(s)
Read input: first set of factors cards
Input cards: numbers 11, 12, and 13
Read input: second set of factors cards
Input cards: number 14
Read input: educational program weights cards
Is sum of weights for each target group = 1 ?
Yes
35
No
32
Print error message: sum of T/P weights not = 1
Read input: personnel/ pupil contacts cards
B

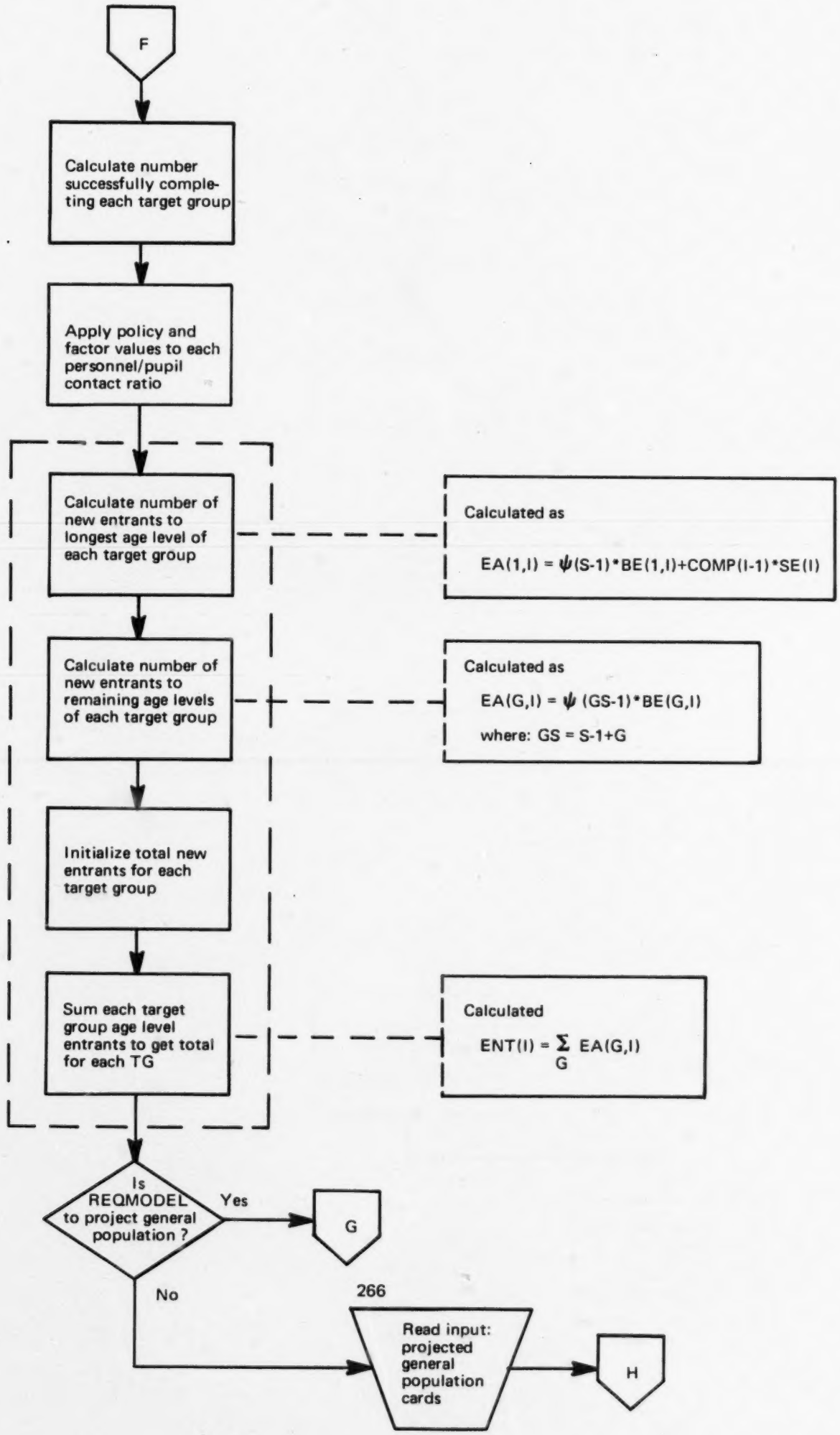
Note: The numbers above the upper left corner of flow symbols refer to the statement numbers in the program listing, Section XV.


B
Read input: target group, personnel, and educational program title cards
Input cards: numbers 17, 18, and 19
Set T = 0 and JUMP = 1
To indicate first time through
Initialize internal variables
Transform personnel/ pupil contacts to contact ratios
TPP = 1/TPP
80
C
Sum each target group age level populations to get total for each TG
Initialize total attritions for each target group
Calculate attritions by age level for each target group
Sum each target group age level attritions to get total for each TG
Loop calculates
AA(G,I) = Σ R P(R,G,I)•A(G,I)
ATT(I) = Σ G AA(G,I)
D

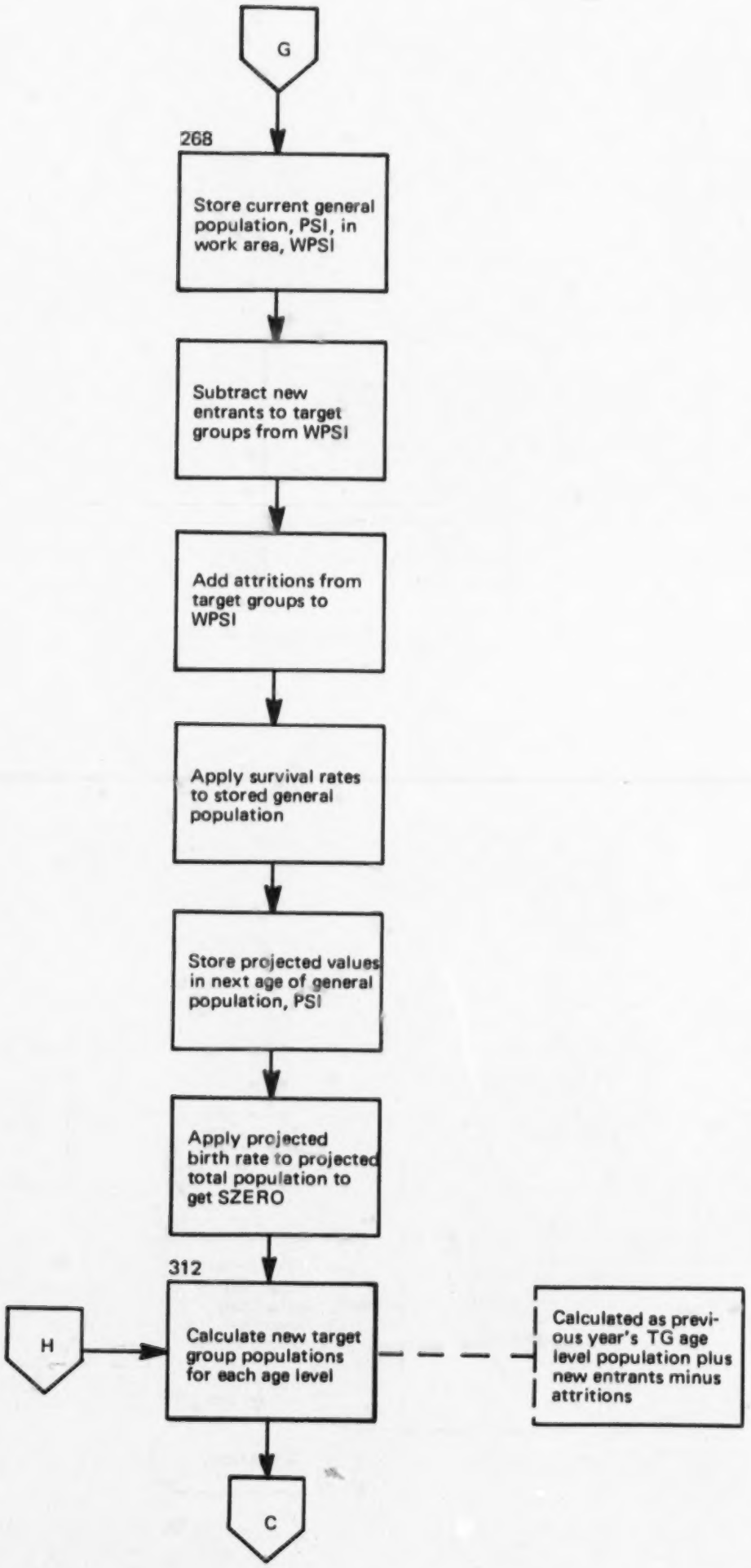
C-7


D
Are program weights cards to be read for each year ?
Yes
86
Is JUMP = 2 ?
Yes
87
Read input: educational program weights cards
No
No
89
Initialize each weighted personnel/ pupil contact ratio
Loop calculates
$TP(K,I) = \sum_{\rho} W(\rho,I) * TPP(\rho,K,I)$
Calculate each weighted personnel/ pupil contact ratio
Initialize demand for each personnel type
Loop calculates
$D(K) = \sum_{I} TP(K,I) * [TG,(I) * \Phi(I)]$
Calculate demand for each personnel type
96
Is T = 0 ?
Yes
No
120
PRINT
Print year's projection results
Is output for each year to be printed ?
Yes
No
E

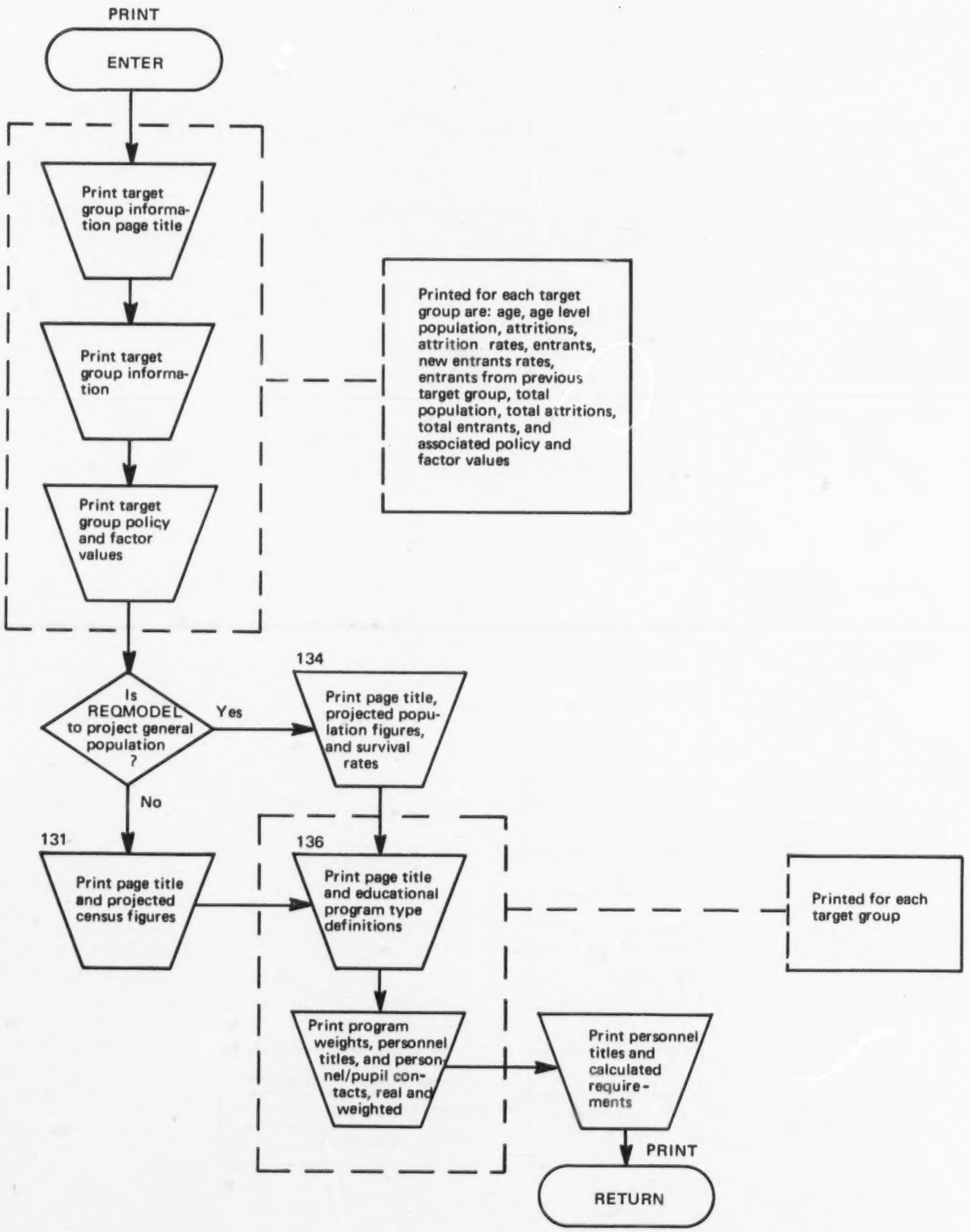

E
156
Is JUMP = 1 ?
Yes
157
Calculate policy and factor variables
No
Set JUMP = 2
159
Have all projection years been completed ?
Yes
997
Has final year's output been printed ?
Yes
No
No
PRINT
Print year's projection results
999
REQMODEL
STOP RUN
160
Set T = T+1
167
Is REQMODEL to project general population ?
Yes
Apply medical technology factor to general population survival rates
No
172
Apply policy and factor values to each target group's entrants and attrition rates
F


F
Calculate number successfully completing each target group
Apply policy and factor values to each personnel/pupil contact ratio
Calculate number of new entrants to longest age level of each target group
Calculated as
EA(1,I) = ψ(S-1)*BE(1,I)+COMP(I-1)*SE(I)
Calculate number of new entrants to remaining age levels of each target group
Calculated as
EA(G,I) = ψ (GS-1)*BE(G,I)
where: GS = S-1+G
Initialize total new entrants for each target group
Sum each target group age level entrants to get total for each TG
Calculated
ENT(I) = Σ EA(G,I)
G
Is REQMODEL to project general population ?
Yes
G
No
266
Read input: projected general population cards
H

C-10


G
268
Store current general population, PSI, in work area, WPSI
Subtract new entrants to target groups from WPSI
Add attritions from target groups to WPSI
Apply survival rates to stored general population
Store projected values in next age of general population, PSI
Apply projected birth rate to projected total population to get SZERO
312
H
Calculate new target group populations for each age level
Calculated as previous year's TG age level population plus new entrants minus attritions
C

2. Subroutine—PRINT


PRINT
ENTER
Print target group information page title
Print target group information
Print target group policy and factor values
Printed for each target group are: age, age level population, attritions, attrition rates, entrants, new entrants rates, entrants from previous target group, total population, total attritions, total entrants, and associated policy and factor values
Is REQMODEL to project general population ?
Yes
No
134
Print page title, projected population figures, and survival rates
131
Print page title and projected census figures
136
Print page title and educational program type definitions
Printed for each target group
Print program weights, personnel titles, and personnel/pupil contacts, real and weighted
Print personnel titles and calculated requirements
PRINT
RETURN

V. JOB CONTROL LANGUAGE

Since the REQMODEL program is written in FORTRAN IV, it can be run under any job control language that has the capability of compiling it. The program testing has been done under CDC 3100 SCOPE and CDC 3100 DOS.

VI. PRODUCTION CONTROL INSTRUCTIONS

As the REQMODEL program requires no tapes or disks, requires no special scheduling, and has no restart procedures, the only production control concerns the input cards and the output paper. The program user and his technical representative should ensure that the card deck submitted for a run contains the properly placed and formatted input cards. The user should request 3-part paper for the output.

VII. LAYOUT OF PROGRAMS

A. REQMODEL accepts input directly from cards (or card images) and produces output directly on the line printer (or in print line image). The program does not use any input/output work areas.

B. The values of all variables and parameters used by the REQMODEL program are either inputted or calculated, directly or indirectly, from the inputs. Thus, the program does not contain any fixed and variable constants or any tables.

VIII. DETAILED PROGRAM DESCRIPTION

A. The purpose of the REQMODEL program is to project the manpower requirements in the field of special education. The program is based upon the mathematical model that was presented in a technical report[1/] prepared under Contract No. OEC-0-9-08928-0710 for the Bureau of Education for the Handicapped (OE-HEW). The model is based upon the concept of grouping the handicapped children into educationally meaningful categories, by handicap and education level, called target groups. For example, a target group could be defined as emotionally disturbed children at the elementary level, or as physically handicapped children at the secondary level. The concept of personnal/pupil contacts by educational program type (e.g., day special class, resource room) is also used by the model and the REQMODEL program.

The Manpower Requirements Projection Model can simulate present and future requirements under varying assumptions regarding changes in the proportion of a target group to be served in special education, the educational

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1/ R.G. Bruce, M.J. Allard, B.A. Johns, and F.L. McCoy, Study of the Need for Educational Manpower for Handicapped Children and Youth—Phase I Report, December 1968.

program mixes (as manifested in personnel ratios) offered a target group, or any combination of these variables. Estimates of present requirements can therefore be generated on the basis of both existing service levels and program choices as well as more idealized circumstances. Future requirements can be estimated in a similar manner. The results of these simulations will provide important insights regarding the manpower implications of improving service levels, programs, or both. In a similar manner, they will indicate the impacts of target group growth and observable changes in educational policy and practices. Finally, the structure of the model permits its application to the estimation of both national and regional requirements.

The model is designed for use in the estimation of manpower requirements at either the state or local level. Its formulation permits the influence of differences in target group definitions, values of growth and attrition rates, program choices, and other detailed variables to be revealed in the requirements estimates. As a result, compilation of this information to form estimates of manpower needs at the national level will be more credible than those produced by a model employing input variables and parameters fixed in value at the national level.

B. The main program, REQMODEL, reads all of the input cards and performs all of the projection calculations. In order to calculate the demand, or requirements, for personnel of a given occupation, the target group populations and the weighted (by the proportion of children served in each educational program) personnel/pupil contact ratios, also called personnel input proportions, must be projected.

The calculations to project the target group populations are classified as the Target Group Submodel. Each target group is composed of age levels, one for each chronological age; the program sums the number of children in each age level to get the total target group population. In order to calculate the projected number of children in each age level of a target group, the program applies the appropriate entrants and attrition rates to simulate the movement of children into and out of the target group. These rates can be subjected to simulations of real-world influences through the use of factors inputted into the program. The entrants rate is applied to the projected general child population to determine the number of new entrants to the target group, while the attrition rates are applied to the target group populations to determine the number of children leaving the target group. The REQMODEL program allows the user the option of inputting the projected general child population, by single year of age (0-21), or of having the program project that population according to a simple algorithm. The former option is the most desirable.

The calculations to project the personnel/pupil contact ratios of each personnel type, for each educational program and their weighted average, are classified as the Personnel Input Submodel. The program sums the products of the personnel pupil contact ratio for each educational program multiplied by the associated program weight to get the weighted personnel/pupil contact ratios. The unweighted contact ratios can also be subjected to simulations of real-world influences through the use of factors inputted into the program. The REQMODEL allows the user the option of using the same program weights for each projection year or of inputting different program weights for each projection year. The latter option is most desirable.

After the programmed submodels have calculated the target group populations and the weighted personnel/pupil contact ratios for the projection year, REQMODEL calculates the demand, or requirements, for each type of personnel and transfers control to the PRINT subroutine if the user wishes the output printed for that year. The sole function of PRINT is to print the output in a series of legible formats. When control is returned to REQMODEL, the program begins the calculations for the next projection year.

C. Mathematically the basic model formula for calculating the demand at a point in time for each personnel type is written as

$$D_{kt} = \sum_{i=1}^{m} \left[(T/P)_{ki} (TG_i) \varphi_i \right]$$

where D = number of occupation k required at time t

T/P = personnel/pupil contact ratio (as a manifestation of program application)

TG = population of target groups, handicap/age

k = occupation type

i = target group

m = total number of target groups

t = point in time

φ = participation factor ($0 \geq \varphi \geq 1$) of TG_i in special education

The Target Group Submodel, used to project the target group populations to be inserted into the model's basic equation, is expressed as

$$(TG_i)_t = (TG_i)_{t-1} + (ENT_i)_{t'} - (ATT_i)_{t'}$$

where ENT = no. of new entrants to TG_i

t' = time interval from t-1 to t

ATT = no. of attritions from TG_i.

Representing the age levels within TG_i by $(A_1, A_2, A_g, \ldots A_{n_i})$, where n_i is the total number of age levels in TG_i, the following identity holds:

$$\left[TG_i \right]_t = \left[\sum_{g=1}^{n_i} \right] (A_g)_i \quad t.$$

The number of children at age level g within TG_i at any time t can be represented as

$$A_{git} = (EA_{gi't} \qquad \text{for } g=1$$

$$A_{git} = (A_{g-1,i't-1} + (EA_{g,i't'} - (AA_{g-1,i't'} \qquad \text{for } g=2, \ldots, n_i$$

where EA = no. of new entrants to age level g in TG_i

AA = no. of attritions from age level g in TG_i.

The number of attritions, by age level, for a target group is calculated as follows:

$$(AA_{gi't'} = \sum_{r=1}^{nc} (p_{rg'i,t-1} \cdot (A_{gi't-1}$$

$$(ATT_{i't'} = \sum_{g=1}^{n_i} (AA_{gi't'} + \left[(A_{n_i it} - (AA_{n_i it}\right]$$

$$= \sum_{g=1}^{n_i-1} (AA_{gi't'} + (A_{n_i it}$$

where p_{rg} = probability of attrition due to reason r (e.g., return to normal education, moved, mortality)

nc = number of attrition categories

n_i = number of age levels in the target group.

The number of entrants, by age level, for a target group is calculated as

$$(EA_{gi't'} = \left[\psi_{s-1} \cdot (E_{gi}\right] t-1$$

where ψ = no. of children of age s in the general child population

E = proportion of children of a chronological age corresponding to age level g who need special education for the first time at age level g

s = chronological age which corresponds to the chronological age of level g in TG_i.

The lowest age level of a target group can also receive as new entrants the graduates of the highest age level of the previous target group if the handicapping

conditions of the two target groups are the same. Thus, for age level 1, the above equation becomes

$$(EA_{1it'}) = \left[\psi_{s-1} \cdot (E_{1i})\right]_{t-1} + \left[COMP_{i-1}\right]_{t}$$

where COMP = number of children from age level n_{i-1} who graduate from TG_{i-1} and who will enter TG_i at age level 1.

The formula for the total new entrants is thus

$$(ENT_{it'}) = \sum_{g=1}^{n_i} (EA_{git'}) .$$

For the general child population, projections of children of age 0 are calculated differently from those of children of ages 1 to 21. The equation for predicting the number of births is

$$(\psi_{st}) = (B_t) \cdot (POP)_t \qquad \text{for } s = 0$$

where ψ = number of children of age s in the general child population

B = the projected birth rate

POP = the projected total population.

The number of children in the remaining ages is calculated as

$$(\psi_{st}) = (\psi_{s-1})_{t-1} \cdot (\mu_{s-1})_{t-1} + \left[\sum_{i-1}^{n} (AA_{g-1})_i\right]_{t-1} - \sum_{i-1}^{n} \left[EA_{gi}\right]_t$$

where the chronological age represented by g-1 equals s-1.

The Personnel Input Submodel, used to project the weighted personnel/pupil contact ratios to be inserted into the model's basic equation, is expressed as

$$(T/P)_{kit} = \sum_{\rho} w_{\rho it} \cdot (T/P)_{\rho kit}$$

where k = occupation type

ρ = educational program type

R = total number of educational programs

w = proportion of children served in TG_i participating in educational program ρ (the program weights

and where $\sum_{\rho} w_{\rho it} = 1$.

D. As is evident upon inspection of the mathematical exposition of the Manpower Requirements Projection Model presented in the above subsection, the model uses iterative processes in most of its calculations. These processes do not require any unusual programming techniques.

E. The REQMODEL program has no specific control or audit provisions.

IX. INPUT DOCUMENTATION

A. All Model Program input is on cards. The data elements that are punched on the cards come from four basic sources. The following is a breakdown of the data elements by source:

1. A special education information system
   - Target group populations, by age level.
2. Calculations based upon data collected by a special education information system
   - Attrition rates of children from the handicapped child population, by reason for attrition, age level, and target group
   - Entrants rates of children to the handicapped child population, by age level and target group.
3. A general, state-wide information source or system
   - Number of children in the general population, by chronological age
   - Projected birth rates for the general population
   - Projected total state populations
   - Survival rates for the children in the general population, by chronological age
   - Projected numbers of children in the general population, by chronological age.
4. Experts in the respective fields, mostly special educators in state departments of special education
   - All program control parameters and set-up information
   - Participation rates, by target group
   - Target group indicators
   - Medical technology factor values, as they would affect both the general population and the handicapped child population, by target group

- Diagnostic technology factor values, by target group
- Educational technology factor values, by personnel type
- Personnel input policy and/or practice factor values, by personnel type and educational program type
- Current and projected educational program weights, by target group
- Personnel/pupil contacts, by personnel type, educational program type, and target group
- Titles for each target group, each personnel type, and each educational program type.

B. Once all inputs have been punched on cards in the proper format, the input cards should accompany the Model Program card deck for the computer run. When the computer run is completed, the input cards should be returned to the run requester, who should store all the cards for possible use in future REQMODEL runs.

C. Input Card Sequence

1. Control Parameters Card
2. Information Card(s)—number of age levels in each target group
3. Information Card(s)—lowest chronological age in each target group
4. Participation Rates Card(s)
5. Target Group Populations Cards
6. Attrition Rates Cards
7. General Population Cards

The following group of cards, #8, is optional. If column 10 of the Control Parameters Card (#1) is = 2, the cards must be included; otherwise the cards must be omitted.

8. a) Birth Rates Cards
   b) Projected Total Population Cards
   c) Survival Rates Cards
   d) General Population Medical Technology Factor Card
9. New Entrants Rates Cards
10. Target Group Indicators Card(s)

11. Medical Technology Factors Card(s)

12. Educational Policy/Practice Factors Card(s)

13. Diagnostic Technology Factors Card(s)

14. Educational Technology Factor and Personnel Input Policy/Practice Factors Cards

15. Educational Program Weights Cards

16. Personnel/Pupil Contacts Cards

17. Target Group Titles Cards

18. Personnel Type Titles Cards

19. Educational Program Type Titles Cards

The following two groups of cards, #20 and #21, are optional. If column 10 of the Control Parameters Card (#1) is = 1, the cards for #20 must be included, one set of cards for each projection year. If both groups of cards are to be included, the order is as follows: #20 for projection year 1, #21 for projection year 1, #20 for projection year 2, #21 for projection year 2, #20 for projection year 3, etc.

20. Estimated General Population Cards

21. Estimated Educational Program Weights Cards

D. Formats of Input Cards

1. Control Parameters Card:

All numbers must be right justified within each field (I5).

Columns 4-5 — number of years or projection desired (≤ 10)

10 — = 1 if projections of general school age populations are to be inputted for each projection year

= 2 if projections of general school age population are to be performed internally

15 — = 1 if output for all years of projection is to be printed

= 2 if only initial data and output for final projection year are to be printed

16-20 — number of target groups (≤ 22)

21-25 — number of different types of educational programs (≤ 6)

26-30 — number of different types of special education personnel (≤ 25)

35 — = 1 if program weights are to be inputted for each projection year

= 2 if same program weights are to be used throughout run

40 — maximum number of attrition categories for a target group (≤ 4)

45 — number of attrition category* representing the reason "return to normal education"

50 — number of the attrition category* representing the reason "mortality."

2. Information Card(s)—number of age levels (≤ 9) in each target group:

First card

Column 5 — number of age levels in target group #1

10 — number of age levels in target group #2

⋮

50 — number of age levels in target group #10

⋮

80 — number of age levels in target group #16

Second card (if necessary)

Column 5 — number of age levels in target group #17, etc.

3. Information Card(s)—lowest chronological age in each target group:

All numbers must be right justified within each field (I5).

First card

Columns 4-5 — lowest chronological age in target group #1 etc., as for #2 above.

4. Participation Rates Card(s)—proportion of children in each target group who are, or are assumed will be, served by special education programs:

All numbers must be left justified within each field (F8.8) unless the decimal point is punched.

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* If no such attrition category is defined, enter a zero in the column.

First card

Columns 1-8 — proportion of children in target group #1 who are, or are assumed will be, served by special education programs

9-16 — same as above for target group #2

⋮

73-80 — proportion of children in target group #10 who are, or are assumed will be, served by special education programs

Second card (if necessary)

Columns 1-8 — proportion of children in target group #11 who are, or are assumed will be, served by special education programs

etc., for as many target groups as exist.

5. Target Groups Populations Cards—number of children, by age, in each target group at the beginning of the projection period:

All numbers must be right justified within each field (F8.0) unless the decimal point is punched.

First card

Columns 1-8 — number of children in the first age level of target group #1

9-16 — number of children in the second age level of target group #1

etc., in the same format for as many age levels as exist in target group #1[2/]

Second card

Columns 1-8 — number of children in the first age level of target group #2

etc.[2/]

Additional cards — in the same format for as many target groups as exist

6. Attrition Rates Cards—proportion of children in each target group who can be expected to drop out of the group for a given reason

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2/ If the group contains more than 10 age levels, use another card for the 11th, 12th, etc.

during a year:

All numbers must be left justified within each field (F8.8) unless the decimal point is punched.

First card: rates for age levels in target group #1 and reason #1.

Columns 1-8 — proportion of children in the first age level of target group #1 who can be expected to drop out of the group for reason #1

9-16 — proportion of children in the second age level of target group #1 who can be expected to drop out of the group for reason #1

etc., to the last age level of target group #1, reason #1

Second card: rates for age levels in target group #1 and reason #2 [3]

Columns 1-8 — proportion of children in the first age level of target group #1 who can be expected to drop out of the group for reason #2

etc., to the last age level of target group #1, reason #2

Additional cards—in the same format for as many reasons within each target group and as many target groups as exist. [4]

7. General Population Cards—number of children, by age (0-21), in the general population at the beginning of the projection period:

All numbers must be right justified within each field (F8.0) unless the decimal point is punched.

First card

Columns 1-8 — number of children in chronological age 0

9-16 — number of children of chronological age 1

⋮

57-64 — number of children of chronological age 7

Second card

Columns 1-8 — number of children of chronological age 8

⋮

57-64 — number of children of chronological age 15

---

[3] If only one reason is being used, the second card would be used for target group #2, etc.

[4] Since the data are read into a matrix, there must be the same number of reasons represented (if only by a blank card) for each target group.

Third card

Columns 1-8 — number of children of chronological age 16

⋮

41-48 — number of children of chronological age 21

8. (Optional)

(a) Birth Rates Cards—projected birth rate (representing the expected number of births divided by the number of persons in the total population) for each year of projection desired, as indicated in columns 4-5 of the Control Parameters Card (#1 above):

All numbers must be left justified within each field (F8.8) unless the decimal point is punched.

First card

Columns 1-8 — projected birth rate for the first projection year

9-16 — projected birth rate for the second projection year

⋮

73-80 — (if necessary) in the same format for the tenth projection year, etc.

(b) Projected Total Population Cards — projected total population for each year of projection desired:

All numbers must be right justified within each field (F8.0) unless the decimal point is punched.

First card

Columns 1-8 — projected number of persons in the total population for the first projection year

etc., as for #8a above

(c) Survival Rates Cards — survival rate of each age level in the general population:

All numbers must be left justified within each field (F8.8) unless the decimal point is punched.

First card

Columns 1-8 — survival rate of children of chronological age 0

9-16 — survival rate of children of chronological age 1

⋮

57-64 — survival rate of children of chronological age 7

Second and third cards — in the same columns as for #7 above.

(d) General Population Medical Technology Factor Card—estimated annual effect (expressed as a proportion) of medical technology directly on the set of survival rates for the general population:

This number must be left justified within the field (F8.8) unless the decimal point is punched.

Columns 1-8 — value of the general population medical technology factor (effect)

9. New Entrants Rates Cards — proportion of children in the general population who can be expected to enter each age level of each target group (i.e., become eligible for special education) during a year:

All numbers must be left justified within each field (F8.8) unless the decimal point is punched.

First card

Columns 1-8 — proportion of children in the chronological age of the general population corresponding to the first age level of target group #1 who can be expected to enter the group

9-16 — proportion of children in the chronological age of the general population corresponding to the second age level of target group #1 who can be expected to enter the group

etc., to the last age level of target group #1

Additional cards — rates for all age levels in remaining target groups.

10. Target Group Indicators Card(s) — an indicator of where in the list of target groups a new handicapping conditions begins.

First card

Column 5 — indicator for target group #1; must equal zero

10 — = 0, if target group #2 represents a handicapping condition different from that of target group #1

= 1, if the handicapping conditions of target groups #1 and #2 are the same

15 — = 0, if target group #3 represents a handicapping condition different from that of target group #2

= 1, if the handicapping conditions of target groups #2, and #3 are the same

etc., in the same format for as many target groups as exist.

11. Medical Technology Factors Card(s) — estimated annual effect (expressed as a proportion) of medical technology, directly on relevant non-mortality attrition rates and inversely on mortality attrition rates and on new entrants rates, for each target group:

All numbers must be left justified within each field (F8.8) unless the decimal point is punched.

First card

Columns 1-8 — value of the medical technology factor (effect) for target group #1

9-16 — value of the medical technology factor (effect) for target group #2

etc., in the same format for as many target groups as exist.

12. Educational Policy/Practice Factors Card(s) — estimated annual effect (expressed as a proportion) of educational policy and/or practice, directly on new entrants rates and inversely on relevant non-mortality attrition rates, for each target group:

All numbers must be left justified within each field (F8.8) unless the decimal point is punched.

First card

Columns 1-8 — value of the educational policy/practice factor (effect) for target group #1

9-16 — value of the educational policy/practice factor (effect) for target group #2

etc., in the same format for as many target groups as exist.

13. Diagnostic Technology Factors Card(s) — estimated annual effect (expressed as a proportion) of diagnostic technology, directly on new entrants rates, for each target group:

All numbers must be left justified within each field (F8.8) unless the decimal point is punched.

First card

Columns 1-8 — value of the diagnostic technology factor (effect) for target group #1

9-16 — value of the diagnostic technology factor (effect) for target group #2

etc., in the same format for as many target groups as exist.

14. Educational Technology Factor and Personnel Input Policy/Practice Factors Cards — estimated annual effect (expressed as a proportion) of educational technology inversely on the recommended personnel/pupil contact ratio (averaged across all education programs) for each personnel type, and the estimated annual effect (expressed as a proportion) of personnel/pupil contact ratio for each educational program used for each personnel type:

All numbers must be left justified within each field (F8.8) unless the decimal point is punched.

First card

Columns 1-8 — value of the educational technology factor (effect) for personnel type #1

9-16 — value of the personnel input policy/practice factor (effect) for personnel type #1 working in educational program type #1

17-24 — value of the personnel input policy/practice factor (effect) for personnel type #1 working in educational program type #2

etc., in the same format for as many educational programs as exist

Second card

Columns 1-8 — value of the educational technology factor (effect) for personnel type #2 working in educational program type #1

etc., in the same format as for first card above for as many educational programs as exist

Additional cards — in the same format for as many personnel types as exist.

15. Educational Program Weights Cards — proportion of each target group's enrolled (in special education) population who are being, or are assumed will be, served by each educational program type:

All numbers must be left justified within each field (F8.8) unless the decimal point is punched, and all numbers on a card must add up to 1.

First card

Columns 1-8 — proportion of target group #1's enrolled population who are assumed will be served educational program type #1

9-16 — proportion of target group #1's enrolled population who are assumed will be served by educational program type #2

etc., in the same format for as many types of educational programs as exist

Additional Cards — in the same format for as many target groups as exist.

16. Personnel/Pupil Contacts Cards — the personnel/pupil contacts (the number of children served by each personnel during a time period, e.g., a week for most personnel, a year for speech therapists) for each type of personnel working within each education program type for each target group:

All numbers > 0 must be right justified within each field (F5.0) unless the decimal point is punched.

First set of cards

First card

Columns 1-5 — number of children served by each personnel type #1 working in educational program type #1 for target group #1 5/

6-10 — number of children served by each personnel type #2 working in educational program type #1 for target group #1

⋮

76-80 — number of children served by each personnel type #15 working in educational program type #1 for target group #1

- Use additional card(s) if there are more than 15 personnel types

Second card

Columns 1-5 — number of children served by each personnel type #1 working in educational program type #2 for target group #1

5/ If the personnel type does not work in the educational program or for the target group, either leave the field blank or enter a zero in the field.

etc., in the same format for the remaining personnel types working in educational program type #2 for target group #1.

Additional cards — in the same format for as many educational program types as exist

Second set of cards

First card

Columns 1-5 — number of children served by each personnel type #1 working in educational program type #1 for target group #2

etc., in the same format for the remaining personnel types working in educational program type #1 for target group #2

Additional cards — in the same format for as many educational program types as exist

Additional sets of cards

In the same format for as many target groups as exist

17. Target Group Titles Cards — prose description or title of each target group:

Up to 48 characters may be used for the title.

First card

Columns 1-48— title of target group #1

Second card

Columns 1-48 — title of target group #2

Additional cards — in the same format for as many target groups as exist.

18. Personnel Type Titles Cards — prose description or title of each personnel type:

Up to 36 characters may be used for the title.

First card

Columns 1-36 — title of personnel type #1

Second card

Columns 1-36 — title of personnel type #2

Additional cards — in the same format for as many personnel types as exist.

19. Educational Program Type Titles Cards — prose description or title of each educational program type:

Up to 24 characters may be used for the title.

First card

Columns 1-24 — title of educational program type #1

Second card

Columns 1-24 — title of educational program type #2

Additional cards — in the same format for as many types of educational programs as exist.

20. (Optional) Estimated General Population Cards — projected number of children, by age (0-21), in the general population at the beginning of a particular year, for all years of the projection period:

All numbers must be right justified within each field (F8.0) unless the decimal point is punched.

First set of cards — for projection year 1

First card

Columns 1-8 — projected number of children of chronological age 0 at the beginning of projection year 1

9-16 — projected number of children of chronological age 1 at the beginning of projection year 1

⋮

57-64 — projected number of children of chronological age 7 at the beginning of projection year 1

Second card

Columns 1-8 — projected number of children of chronological age 8 at the beginning of projection year 1

⋮

57-64 — projected number of children of chronological age 15 at the beginning of projection year 1

Third card

Columns 1-8 — projected number of children of chronological age 16 at the beginning of projection year 1

⋮

41-48 — projected number of children of chronological age 21 at the beginning of projection year 1

Second set of cards — for projection year 2

First card

Columns 1-8 — projected number of children of chronological age 0 at the beginning of projection year 2

etc., in the same format as the First Card of the First Set

Second and third cards — in the same format for projection year 2 as the second and third cards of the first set

Additional sets of cards — in the same format as the First Set for as many projection years as specified in columns 4-5 of the Control Parameters Card (#1).

21. (Optional) Estimated Educational Program Weights Cards — estimated proportion of each target group's enrolled (in special education) population who are being or are assumed will be served by each educational program type for each projection year:

All numbers must be left justified within each field (F8.8) unless the decimal point is punched, and all numbers on a card must add up to 1.

First set of cards — for projection year 1

First card

Columns 1-8 — estimated proportion of target group #1's enrolled population who are assumed will be served by educational program type #1 for projection year 1

9-16 — estimated proportion of target group #1's enrolled population who are assumed will be served by educational program type #2 for projection year 1

etc., in the same format for as many types of educational programs as exist

Additional cards — in the same format as the first card for as many target groups as exist for projection year 1

Second set of cards — for projection year 2

First card

Columns 1-8 — estimated proportion of target group #1's enrolled population who are assumed will be served by educational program type #1 for projection year 2

etc., in the same format for as many types of educational programs as exist

Additional cards — in the same format as the first card for as many target groups exist for projection year 2

Additional sets of cards — in the same format as the first set for as many projection years as specified in Columns 4-5 of the Control Parameters Card (#1).

E. No format controls have been established for the handling of or verification of the input cards, but the following recommendations should be considered.

1. The run requester should be responsible for providing the input data to the keypunching facilities
2. A technical representative, designated by the run requester, should be responsible for verifying the punched input by inspecting a printed list of the cards
3. The above technical representative should be responsible for submitting the input cards with the Model Program card deck for all computer runs
4. At the completion of the computer run, the input cards should be returned to the run requester, via his designated technical representative.

F. Internal Data Names and Definitions

A — A two-dimensional matrix used to store the number of children in each age level of each target group; each row stores the age level populations for a particular target group; the matrix size limit is 9 x 22.

AA — A two-dimensional matrix used to store the number of children attriting from each age level of each target group; each row stores the age level attritions for a particular target group; the matrix size limit is 9 x 22.

AGE — An index used to represent a particular chronological age in general population calculations.

ALPHA — A one-dimensional matrix (or vector) used to store the medical technology factor values for each target group; the matrix size limit is 22.

ATT — A one-dimensional matrix (or vector) used to store the total number of attritions from each target group; the matrix size limit is 22.

B — A one-dimensional matrix (or vector) used to store the projected birth rates for each year of projection desired; the matrix size limit is 10.

BE — A two-dimensional matrix used to store the new entrants rates of children from the general population into each age level of each target group; each row stores the age level entrants rates for a particular target group; the matrix size limit is 9 x 22.

BETA — A one-dimensional matrix (or vector) used to store the education policy/practice factor values for each target group; the matrix size limit is 22.

COMP — A one-dimensional matrix (or vector) used to store the number of children successfully completing their education (i.e., non-attritions) in the highest age level of each target group; the matrix size limit is 22.

D — A one-dimensional matrix (or vector) used to store the number of personnel required for each personnel type; the matrix size limit is 25.

DT — A one-dimensional matrix (or vector) used to store the diagnostic technology parameter values (= 1 + GAMMA) for each target group; the matrix size limit is 22.

EA — A two-dimensional matrix used to store the number of children newly entering each age level of each target group; each row stores the age level entrants for a particular target group; the matrix size limit is 9 x 22.

ENT — A one-dimensional matrix (or vector) used to store the total number of new entrants to each target group; the matrix size limit is 22.

EP — A one-dimensional matrix (or vector) used to store the educational policy/practice parameter values (= 1 + BETA) for each target group; the matrix size limit is 22.

ET — A one-dimensional matrix (or vector) used to store the educational technology parameter values (= 1 + THETA) for each personnel type; the matrix size limit is 25.

ETA — A two-dimensional matrix used to store the personnel input policy/practice factor values for each educational program type and each personnel type; each row stores the factor values of all educational program types for a particular personnel type; the matrix size limit is 6 x 25.

FT — The input parameter used to store the number of years of projection desired.

G — An index used to represent a particular age level within a target group.

GAMMA — A one-dimensional matrix (or vector) used to store the diagnostic technology factor values for each target group; the matrix size limit is 22.

GS — An index used to represent the chronological age + 1 of a particular age level within a target group.

I — An index used to represent a particular target group.

IFPOP — The input parameter used to indicate the general school age population projection options.

IPRNT — The input parameter used to indicate the output printing options.

IPW — The input parameter used to indicate the program weights input options.

J — The input parameter used to store the number of educational program types.

JUMP — A parameter used to indicate the first projection year (= 1) or subsequent projection years (= 2).

K — An index used to represent a particular personnel type.

L — A working index used to input titles.

LA — A one-dimensional matrix (or vector) used to store the actual chronological age of the lowest age level of each target group; the matrix size limit is 22.

LAMBDA — The input parameter used to store the general population medical technology factor value.

M — The input parameter used to store the number of personnel types.

MORT — The input parameter used to store the number of the attrition category representing the reason "mortality," if such a reason is defined by the user.

MT — A one-dimensional matrix (or vector) used to store the medical technology parameter values (= 1 + ALPHA) for each target group; the matrix size limit is 22.

MTN — A variable used to store the general population medical technology parameter value (= 1 + LAMBDA).

MU — A one-dimensional matrix (or vector) used to store the survival rates for each chronological age (1-21) in the general population; the matrix size limit is 21.

MUZERO — A variable used to store the survival rate for chronological age 0 in the general population.

N — The input parameter used to store the number or target groups.

NAC — The input parameter used to store the maximum number of attrition categories for any target group.

NEDUC — The input parameter used to store the number of the attrition category representing the reason "return to normal education," if such a reason is defined by the user.

NI — A one-dimensional matrix (or vector) used to store the number of age levels in each target group; the matrix size limit is 22.

NN — A variable used to store the number of age levels in a particular target group.

P — A three-dimensional matrix used to store the attrition rates of children from the handicapped child population for each reason of attrition, each age level, and each target group; each plane of the matrix stores the attrition rates, by age level and reason for attrition, for a particular target group; the matrix size limit is 4 x 9 x 22.

PERSON — A two-dimensional matrix used to store the prose titles of each personnel type; each row stores the title of a particular personnel type; the matrix size limit is 25 x 9.

PHI — A one-dimensional matrix (or vector) used to store the participation (in special education) rates for each target group; the matrix size limit is 22.

PI — A two-dimensional matrix used to store the personnel input policy/practice parameter values (= 1 + ETA) for each educational program type and each personnel type; each row stores the parameter values of all educational program types for a particular personnel type; the matrix size limit is 6 x 25.

POP — A one-dimensional matrix (or vector) used to store the projected total general population for each year of projection desired; the matrix size limit is 10.

PROGT — A two-dimensional matrix used to store the prose titles of each educational program type; each row stores the title of a particular educational program type; the matrix size limit is 6 x 6.

PSI — A one-dimensional matrix (or vector) used to store the number of children in the general population having each chronological age, 1-21; the matrix size limit is 21.

R — An index used to represent a particular reason for attrition in the target group attrition calculations.

RHO — An index used to represent a particular educational program type.

S — An index used to represent chronological age.

SE — A one-dimensional matrix (or vector) used to store the target group indicators, i.e., flags of whether the target group represents the same or a different handicapping condition as the previous target group in the list; the matrix size limit is 22.

SZERO — A variable used to store the number of children in the general population having the chronological age zero.

T — An index used to represent time, i.e., the projection year of the current calculations.

TG — A one-dimensional matrix (or vector) used to store the number of children in each target group; the matrix size limit is 22.

TGTITL — A two-dimensional matrix used to store the prose titles of each target group; each row stores the title of a particular target group; the matrix size limit is 22 x 12.

THETA — A one-dimensional matrix (or vector) used to store the educational technology factor values for each personnel type; the matrix size limit is 25.

TP — A two-dimensional matrix used to store the calculated weighted (by educational program type enrollments) personnel/pupil contact ratio of each personnel type and each target group; each row stores the weighted contact ratio of all personnel types for a particular target group; the matrix size limit is 25 x 22.

TPP — A three-dimensional matrix used initially to store the inputted personnel/pupil contacts for each personnel type working within each educational program type for each target group and then used to store the personnel/pupil contact ratio = 1/TPP (initial); each plane of the matrix stores the personnel type by educational program type personnel/pupil contact ratios for a particular target group; the matrix size limit is 6 x 25 x 22.

W — A two-dimensional matrix used to store the educational program weights (i.e., the proportion of enrolled children being served in each educational program type) of each educational program type for each target group; each row stores the weights of all educational program types for a particular target group; the matrix size limit is 6 x 22.

WPSI — A one-dimensional matrix (or vector) used as a working array to store the previous year's general child population (PSI) by chronological age, and to calculate the next projected general child population; the matrix size limit is 22.

G. No internal data records are used by the REQMODEL program.

X. OUTPUT DOCUMENTATION

A. Since all output of the REQMODEL program is directly to the line printer (or in 136 character print line image), there are no internal output record images.

B. The output of the program consists of four sets of printer page formats, generated by the subroutine PRINT, for each projection year for which output is desired. The names and descriptions of the output variables and the printing formats for each set are:

- Set #1 — For each target group, a line for each age level is printed, containing the chronological age (L), number of children (A), estimated number of attritions that will occur during the year (AA), four possible attrition rates (P), entrants that have occurred during the previous year (EA), new entrants rate (BE), and number of new entrants that successfully completed the educational program of the previous target group during the previous year (COMP). These values are printed according to the format: Columns 8 and 9 contain L, Columns 14-23 contain A, Columns 28-37 contain AA, Columns 43-87 contain the four Ps, Columns 91-100 contain EA, Columns 105-113 contain BE, and Columns 117-126 contain COMP. Additionally, the related policy and factor values for the target group are printed at the bottom of each page; these variables are the target group indicator (SE), medical technology factor (MT), educational policy/practice factor (EP), diagnostic technology factor (DT), and participation factor (PHI).

- Set #2 — For the general child population, a line for each chronological age is printed containing the chronological age (S), number of children (PSI) and, if the REQMODEL program projects the population, survival rate (MU). These values are printed according to the format: Columns 8 and 9 contain S, Columns 15-25 contain PSI, and Columns 31-39 contain MU.

- Set #3 — For each target group, the educational program type definitions (PROGT) and the program weights (w) are printed first and then a line for each personnel type having a non-zero TP value is printed, containing the title of the personnel type (PERSON), the personnel/pupil contacts (1./TPP) for each educational program type, and the weighted personnel/pupil contacts (1./TP). These values are printed according to the format: Columns 6-41 contain PERSON, Columns 46-123 contain [1./TPP], and columns 128-136 contain [1./TP].

- Set #4 — For each personnel type, a line is printed containing the title of the personnel type (PERSON) and number required (D). These values are printed according to the format: Columns 10-45 contain PERSON, and Columns 56-65 contain D.

C. Figures 1-4 each present a sample page of each set of outputs. The volume of output produced by the REQMODEL program is controlled by a user option that is inputted. The option allows the user to obtain either (a) the four sets of output for the initial year and each projection year or (b) the four

FOR THE JTH SECONDARY LEVEL

AT TIME T = 10 THE VALUES OF THE INDEPENDENT VARIABLES ARE

AGE	NUMBER	ATHLETICS	P(1)	P(2)	P(3)	P(4)	ENTRANTS	LARGE E	COMP PREV TO LAST YR
11	17.04	.00	.0010989	.0024950	0	0	17.04	.0000300	0
12	101.22	.41	.0010989	.0029940	0	0	17.01	.0000300	
13	95.23	.32	.0009990	.0023952	0	0	17.05	.0000300	
14	90.21	.56	.0008991	.0049900	0	0	14.58	.0000250	
15	93.02	.58	.0008991	.0044910	0	0	17.47	.0000300	
16	91.99	.73	.0009990	.0069860	0	0	20.37	.0000351	
17	92.75	9.76	.0011988	.0499002	0	0	20.33	.0000351	
18	80.99	32.61	.0012987	.3992010	0	0	17.37	.0000300	
19	50.89	50.76	.0014985	.9965070	0	0	17.34	.0000300	
TOTAL	716.82	99.51					160.24		

SCHOOL E = 1.00000000

PHYSICAL TECHNOLOGY = 2.00100000

SOCIAL POLICY/PRACTICE = 1.00200000

DIAGNOSTIC TECHNOLOGY = 1.00050000

PARTICIPATION FACTOR = .45000000

FIGURE 1. SAMPLE PAGE OF OUTPUT SET #1

FOR THE WOMENS POPULATION AT TIME T = 1.

THE VALUES OF THE INDEPENDENT VARIABLES ARE

AGE	NUMBER	SURVIVAL RATE
0	6000.20	.9996000
1	600059.00	.9995000
2	599699.85	.9995000
3	599350.55	.9994000
4	599020.30	.9994000
5	598734.60	.9994000
6	598554.55	.9994000
7	598328.62	.9993000
8	598203.55	.9993000
9	598103.05	.9992000
10	598005.15	.9992000
11	597905.60	.9992000
12	597803.05	.9991000
13	597727.32	.9991000
14	597748.04	.9991000
15	597748.06	.9991000
16	597749.67	.9991000
17	597753.01	.9990000
18	597792.14	.9990000
19	579609.96	.9989000
20	577635.99	.9987000
21	575543.13	0

FIGURE 2. SAMPLE PAGE OF OUTPUT SET #2

of item 2 = is the values of the I/P related independent variables

for var 21 = during secondary level AME

PROGRAM TYPE DEFINITIONS = 1 = RESIDENTIAL SCHOOL
2 = DAY SPECIAL CLASS
3 = RESOURCE ROOM

	PROGRAM TYPE						WEIGHTED AVERAGE
	1	2	3	4	5	6	
WEIGHTS (PROPORTION OF CHILDREN IN EACH PROGRAM)	.4000000	.3000000	.3000000				
PERSONNEL/PUPIL CONTACTS FOR ---							
TEACHER OF THE BLIND	7.999	8.999	19.997	*********	*********	*********	10.168
TEACHER AIDE - BLIND	15.968	17.964	39.918	*********	*********	*********	20.298
ORIENTATION INSTRUCTOR - BLIND	29.879	39.839	0	*********	*********	*********	47.807

FIGURE 3. SAMPLE PAGE OF OUTPUT SET #3

AT TIME T = 1. THE REQUIREMENTS ARE

PERSONNEL TYPE	NUMBER REQUIRED
TEACHER OF THE BLIND	129.41
TEACHER AIDE - BLIND	113.73
VOCATIONAL INSTRUCTOR - BLIND	10.52

FIGURE 4. SAMPLE PAGE OF OUTPUT SET #4

sets of output for the initial year and only the final projection year. The volume of output, in number of pages, can be approximated by the calculation:

(number of projection years + 1) X [2(number of target groups + 2)].

All copies (three are recommended) of the output should be returned to the run requester, who should be responsible for the distribution of the extra copies.

D. Since the REQMODEL program produces only printed output, there are no controls established other than that all output should be returned to the run requester. For computer systems having the printer off-line, the output tape containing the print line images need be saved only if the run requester expects to generate additional copies of the printed output. The retention of such an output tape will probably not exceed 6 months.

XI. FILE DESCRIPTIONS

The REQMODEL program is designed such that it does not use any files—input, internal, or output. If the computer system that the program is run on does all of the print off-line, a file containing the 136 character print line images may be created to go off-line. The description and format of such a file are the same as those described for the printed output in Section X, Paragraph B above.

XII. HISTORY LOG

A. The Bureau of Education for the Handicapped and the contractor, Operations Research, Inc. (ORI), agreed that the REQMODEL program would be made available in Standard FORTRAN IV and in IBM 360 FORTRAN IV. The translation of REQMODEL into COBOL by the contractor was not within the scope of the original contract.

B. There have been no major changes made to the program up through 1 April 1970. Because of the program design, it is not anticipated that such changes will have to be made in the future.

XIII. TESTING INFORMATION

A. The REQMODEL program was fully tested with three sets of hypothetical data on a CDC 3100 computer system.

B. During July 1969, a model demonstration was performed. Actual data for the years 1964-68 were collected in a midwestern county and the data for 1964 were inputted into the REQMODEL program. The program then projected the data for the year 1968. These projected data compared favorably to the actual 1968 data collected. The results of this model demonstration are presented in Part A of this report.

XIV. SOURCE LANGUAGE OF PROGRAM

The REQMODEL program is written in FORTRAN IV.

XV. PROGRAM LISTINGS

A. Main Program—REQMODEL

There are two source card decks available for the REQMODEL program; one in Standard FORTRAN IV and one in IBM 360 FORTRAN IV.

This section contains the Standard FORTRAN IV source card listings. The other deck is exactly the same except for the READ and WRITE unit designations (5 and 6 respectively).

```
      PROGRAM REQMODEL                                                  REQMOD
C                                                                       REQMOD
C  SPECIAL EDUCATION MANPOWER REQUIREMENTS PROJECTION MODEL             REQMOD
C                                                                       REQMOD
C                                                                       REQMOD
      INTEGER  AGE, FT, G, GS, PERSON, PROGT, R, RHO, S, T, TGTITL      REQMOD
C                                                                       REQMOD
      REAL  LAMBDA, MT, MTN, MU, MUZERO                                 REQMOD
C                                                                       REQMOD
      COMMON  A( 9,22), AA( 9,22), AGE, ALPHA(22), ATT(22), B(10)       REQMOD
      COMMON  BE( 9,22), BETA(22), COMP(22), D(25), DT(22)              REQMOD
      COMMON  EA( 9,22), ENT(22), EP(22), ET(25), ETA(6,22), FT         REQMOD
      COMMON  G, GAMMA(22), GS, I, IFPOP, IPRNT, IPW, J, JUMP, K        REQMOD
      COMMON  L, LA(22), LAMBDA, M, MT(22), MTN, MU(21), MUZERO         REQMOD
      COMMON  N, NAC, NI(22), NN, P(4, 9,22), PERSON(25,9), PHI(22)     REQMOD
      COMMON  PI(6,25), POP(10), PROGT(6,6), PSI(21), R, RHO            REQMOD
      COMMON  S, SE(22), SZERO, T, TG(22), TGTITL(22,12), THETA(25)     REQMOD
      COMMON  TP(25,22), TPP(6,25,22), W(6,22), WPSI(22)                REQMOD
C                                                                       REQMOD
      READ (60,100)  FT, IFPOP, IPRNT, N, J, M, IPW, NAC, NEDUC, MORT  REQMOD
      READ (60,100)  (NI(I),I=1,N)                                      REQMOD
  100 FORMAT (16I5)                                                     REQMOD
      READ (60,100)  (LA(I),I=1,N)                                      REQMOD
      READ (60,102) (PHI(I),I=1,N)                                      REQMOD
C                                                                       REQMOD
      DO 10  I=1,N                                                      REQMOD
      NN=NI(I)                                                          REQMOD
      READ (60,101)  (A(G,I),G=1,NN)                                    REQMOD
  101 FORMAT (10F8.0)                                                   REQMOD
   10 CONTINUE                                                          REQMOD
C                                                                       REQMOD
      DO 15  I=1,N                                                      REQMOD
      NN=NI(I)                                                          REQMOD
      DO 12  R=1,4                                                      REQMOD
      DO 12  G=1,NN                                                     REQMOD
      P(R,G,I)=0.                                                       REQMOD
   12 CONTINUE                                                          REQMOD
      DO 15  R=1,NAC                                                    REQMOD
      READ (60,102)    (P(R,G,I),G=1,NN)                                REQMOD
  102 FORMAT (10F8.8)                                                   REQMOD
   15 CONTINUE                                                          REQMOD
C                                                                       REQMOD
      READ (60,103)  SZERO,(PSI(S),S=1,21)                              REQMOD
  103 FORMAT (8F8.0)                                                    REQMOD
      LAMBDA=0.                                                         REQMOD
      GO TO (19,16),IFPOP                                               REQMOD
   16 READ (60,102)  (B(S),S=1,FT)                                      REQMOD
      READ (60,101)  (POP(S),S=1,FT)                                    REQMOD
      READ (60,104)  MUZERO,(MU(S),S=1,21)                              REQMOD
```

```
  104 FORMAT (8F8.8)
      READ (60,102)  LAMBDA                                          REQMOD
C                                                                    REQMOD
   19 DO 20  I=1,N                                                   REQMOD
      NN=NI(I)                                                       REQMOD
      READ (60,102)  (BE(G,I),G=1,NN)                                REQMOD
   20 CONTINUE                                                       REQMOD
C                                                                    REQMOD
      READ (60,108)  (SE(I),I=1,N)                                   REQMOD
  108 FORMAT (16F5.0)                                                REQMOD
C                                                                    REQMOD
      READ (60,102)  (ALPHA(I),I=1,N)                                REQMOD
      READ (60,102)  (BETA(I),I=1,N)                                 REQMOD
      READ (60,102)  (GAMMA(I),I=1,N)                                REQMOD
C                                                                    REQMOD
      DO 25  K=1,M                                                   REQMOD
      READ (60,105)  THETA(K),(ETA(RHO,K),RHO=1,J)                   REQMOD
  105 FORMAT (7F8.8)                                                 REQMOD
   25 CONTINUE                                                       REQMOD
C                                                                    REQMOD
      DO 35  I=1,N                                                   REQMOD
      READ (60,105)  (W(RHO,I),RHO=1,J)                              REQMOD
      TEMP=0.                                                        REQMOD
      DO 30  RHO=1,J                                                 REQMOD
      TEMP=TEMP+W(RHO,I)                                             REQMOD
   30 CONTINUE                                                       REQMOD
      IF (TEMP-1.)  32,35                                            REQMOD
   32 WRITE (61,500)  I                                              REQMOD
  500 FORMAT (1H0,46HERROR  -  SUM OF T/P WEIGHTS FOR TARGET GROUP ,I2,  REQMOD
     19H NOT = 1./)                                                  REQMOD
   35 CONTINUE                                                       REQMOD
C                                                                    REQMOD
      DO 37  I=1,N                                                   REQMOD
      DO 37  K=1,M                                                   REQMOD
      DO 37  RHO=1,J                                                 REQMOD
      TPP(RHO,K,I)=0.                                                REQMOD
   37 CONTINUE                                                       REQMOD
      DO 40  I=1,N                                                   REQMOD
      DO 40  RHO=1,J                                                 REQMOD
      READ (60,106)  (TPP(RHO,K,I),K=1,M)                            REQMOD
  106 FORMAT (15F5.0)                                                REQMOD
   40 CONTINUE                                                       REQMOD
C                                                                    REQMOD
      DO 45  I=1,N                                                   REQMOD
      READ (60,107)  (TGTITL(I,L),L=1,12)                            REQMOD
  107 FORMAT (12A4)                                                  REQMOD
   45 CONTINUE                                                       REQMOD
C                                                                    REQMOD
      DO 50  K=1,M                                                   REQMOD
      READ (60,107)  (PERSON(K,L),L=1,9)                             REQMOD
   50 CONTINUE                                                       REQMOD
C                                                                    REQMOD
      DO 55  RHO=1,J                                                 REQMOD
      READ (60,107)  (PROGT(RHO,L),L=1,6)                            REQMOD
   55 CONTINUE                                                       REQMOD
C                                                                    REQMOD
      T=0                                                            REQMOD
C                                                                    REQMOD
```

```
      JUMP=1                                                            REQMOD
      DO 60  I=1,N                                                      REQMOD
      MT(I)=1.                                                          REQMOD
      EP(I)=1.                                                          REQMOD
      DT(I)=1.                                                          REQMOD
   60 CONTINUE                                                          REQMOD
      MTN=1.                                                            REQMOD
      DO 65  K=1,M                                                      REQMOD
      ET(K)=1.                                                          REQMOD
      DO 65  RHO=1,J                                                    REQMOD
      PI(RHO,K)=1.                                                      REQMOD
   65 CONTINUE                                                          REQMOD
      DO 70  I=1,N                                                      REQMOD
      NN=NI(I)                                                          REQMOD
      ATT(I)=0.                                                         REQMOD
      ENT(I)=0.                                                         REQMOD
      COMP(I)=0.                                                        REQMOD
      DO 70  G=1,NN                                                     REQMOD
      AA(G,I)=0.                                                        REQMOD
      EA(G,I)=0.                                                        REQMOD
   70 CONTINUE                                                          REQMOD
C                                                                       REQMOD
      DO 75  I=1,N                                                      REQMOD
      DO 75  K=1,M                                                      REQMOD
      DO 75  RHO=1,J                                                    REQMOD
      IF (TPP(RHO,K,I))  72,75                                          REQMOD
   72 TPP(RHO,K,I)=1./TPP(RHO,K,I)                                      REQMOD
   75 CONTINUE                                                          REQMOD
C                                                                       REQMOD
C                                                                       REQMOD
   80 DO 85  I=1,N                                                      REQMOD
      TG(I)=0.                                                          REQMOD
      NN=NI(I)                                                          REQMOD
      DO 85  G=1,NN                                                     REQMOD
      TG(I)=TG(I)+A(G,I)                                                REQMOD
   85 CONTINUE                                                          REQMOD
C                                                                       REQMOD
      DO 265  I=1,N                                                     REQMOD
      ATT(I)=0.                                                         REQMOD
      NN=NI(I)                                                          REQMOD
      DO 260  G=1,NN                                                    REQMOD
      AA(G,I)=0.                                                        REQMOD
      DO 255  R=1,NAC                                                   REQMOD
      AA(G,I)=AA(G,I)+P(R,G,I)*A(G,I)                                   REQMOD
  255 CONTINUE                                                          REQMOD
      ATT(I)=ATT(I)+AA(G,I)                                             REQMOD
  260 CONTINUE                                                          REQMOD
  265 CONTINUE                                                          REQMOD
C                                                                       REQMOD
      GO TO (86,89), IPW                                                REQMOD
   86 GO TO (89,87), JUMP                                               REQMOD
   87 DO 8  I=1,N                                                       REQMOD
      READ (60,105)  (W(RHO,I),RHO=1,J)                                 REQMOD
   88 CONTINUE                                                          REQMOD
   89 DO 90  I=1,N                                                      REQMOD
      DO 90  K=1,M                                                      REQMOD
      TP(K,I)=0.                                                        REQMOD
      DO 90  RHO=1,J                                                    REQMOD
```

```
      TP(K,I)=TP(K,I)+W(RHO,I)*TPP(RHO,K,I)                              REQMOD
   90 CONTINUE                                                           REQMOD
C                                                                        REQMOD
      DO 95  K=1,M                                                       REQMOD
      D(K)=0.                                                            REQMOD
      DO 95  I=1,N                                                       REQMOD
      D(K)=D(K)+TP(K,I)*TG(I)*PHI(I)                                     REQMOD
   95 CONTINUE                                                           REQMOD
      IF (T)  96,120,96                                                  REQMOD
   96 GO TO (120,156), IPRNT                                             REQMOD
C                                                                        REQMOD
  120 CALL PRINT                                                         REQMOD
C                                                                        REQMOD
  156 GO TO (157,159),JUMP                                               REQMOD
  157 MTN=     (1.+LAMBDA)                                               REQMOD
      DO 158  I=1,N                                                      REQMOD
      MT(I)=       (1.+ALPHA(I))                                         REQMOD
      EP(I)=       (1.+BETA(I))                                          REQMOD
      DT(I)=       (1.+GAMMA(I))                                         REQMOD
  158 CONTINUE                                                           REQMOD
      DO 1158  K=1,M                                                     REQMOD
      ET(K)=       (1.-THETA(K))                                         REQMOD
      DO 1158  RHO=1,J                                                   REQMOD
      PI(RHO,K)=           (1.-ETA(RHO,K))                               REQMOD
 1158 CONTINUE                                                           REQMOD
      JUMP=2                                                             REQMOD
  159 IF (T-FT)  160,997,997                                             REQMOD
  160 T=T+1                                                              REQMOD
C                                                                        REQMOD
      GO TO (172,167),IFPOP                                              REQMOD
  167 MUZERO=MUZERO*MTN                                                  REQMOD
      DO 170  S=1,21                                                     REQMOD
      MU(S)=MU(S)*MTN                                                    REQMOD
  170 CONTINUE                                                           REQMOD
C                                                                        REQMOD
  172 DO 180  I=1,N                                                      REQMOD
      NN=NI(I)                                                           REQMOD
      DO 179  G=1,NN                                                     REQMOD
      BE(G,I)=BE(G,I)*DT(I)*EP(I)*(1./MT(I))                             REQMOD
      DO 179  R=1,NAC                                                    REQMOD
      IF (R-NEDUC)  174,173                                              REQMOD
  173 P(R,G,I)=P(R,G,I)*MT(I)*(1./EP(I))                                 REQMOD
      GO TO 179                                                          REQMOD
  174 IF (R-MORT)  176,175                                               REQMOD
  175 P(R,G,I)=P(R,G,I)*(1./MT(I))                                       REQMOD
      GO TO 179                                                          REQMOD
  176 P(R,G,I)=P(R,G,I)*(1./EP(I))                                       REQMOD
  179 CONTINUE                                                           REQMOD
  180 CONTINUE                                                           REQMOD
C                                                                        REQMOD
      DO 195  I=1,N                                                      REQMOD
      NN=NI(I)                                                           REQMOD
      COMP(I)=           A(NN,I)-AA(NN,I)                                REQMOD
  195 CONTINUE                                                           REQMOD
C                                                                        REQMOD
      DO 225  K=1,M                                                      REQMOD
      DO 225  I=1,N                                                      REQMOD
      DO 225  RHO=1,J                                                    REQMOD
      TPP(RHO,K,I)=TPP(RHO,K,I)*(1./ET(K))*PI(RHO,K)                     REQMOD
  225 CONTINUE                                                           REQMOD
C                                                                        REQMOD
```

```
      DO 250  I=1,N                                                    REQMOD
      S=LA(I)                                                          REQMOD
      EA(1,I)=PSI(S-1)*BE(1,I)+COMP(I-1)*SE(I)                         REQMOD
      NN=NI(I)                                                         REQMOD
      DO 240  G=2,NN                                                   REQMOD
      GS=S-1+G                                                         REQMOD
      EA(G,I)=PSI(GS-1)*BE(G,I)                                        REQMOD
  240 CONTINUE                                                         REQMOD
      ENT(I)=0.                                                        REQMOD
      DO 245  G=1,NN                                                   REQMOD
      ENT(I)=ENT(I)+EA(G,I)                                            REQMOD
  245 CONTINUE                                                         REQMOD
  250 CONTINUE                                                         REQMOD
C                                                                      REQMOD
C                                                                      REQMOD
      GO TO (266,268),IFPOP                                            REQMOD
  266 READ (60,103)  SZERO,(PSI(S),S=1,21)                             REQMOD
      GO TO 312                                                        REQMOD
C                                                                      REQMOD
  268 WPSI(1)=SZERO                                                    REQMOD
      DO 270  AGE=2,22                                                 REQMOD
      WPSI(AGE)=PSI(AGE-1)                                             REQMOD
  270 CONTINUE                                                         REQMOD
C                                                                      REQMOD
      DO 275  I=1,N                                                    REQMOD
      S=LA(I)                                                          REQMOD
      WPSI(S+1)=WPSI(S+1)-PSI(S)*BF(1,I)                               REQMOD
      NN=NI(I)                                                         REQMOD
      DO 275  G=2,NN                                                   REQMOD
      GS=G+S                                                           REQMOD
      WPSI(GS)=WPSI(GS)-EA(G,I)                                        REQMOD
  275 CONTINUE                                                         REQMOD
C                                                                      REQMOD
      DO 290  I=1,N                                                    REQMOD
      S=LA(I)                                                          REQMOD
      NN=NI(I)                                                         REQMOD
      DO 290  G=1,NN                                                   REQMOD
      GS=G+S                                                           REQMOD
      WPSI(GS)=WPSI(GS)+AA(G,I)                                        REQMOD
  290 CONTINUE                                                         REQMOD
C                                                                      REQMOD
      WPSI(1)=WPSI(1)*MUZERO                                           REQMOD
      DO 300  AGE=2,22                                                 REQMOD
      WPSI(AGE)=WPSI(AGE)*MU(AGE-1)                                    REQMOD
  300 CONTINUE                                                         REQMOD
C                                                                      REQMOD
      DO 310  AGE=1,21                                                 REQMOD
      PSI(AGE)=WPSI(AGE)                                               REQMOD
  310 CONTINUE                                                         REQMOD
      SZERO=B(I)*POP(I)                                                REQMOD
C                                                                      REQMOD
C                                                                      REQMOD
  312 DO 320  I=1,N                                                    REQMOD
      NN=NI(I)                                                         REQMOD
      S=NN-1                                                           REQMOD
      DO 315  G=1,S                                                    REQMOD
      GS=NN+1-G                                                        REQMOD
```

```
      L=GS-1                                                            REQMOD
      A(GS,I)=A(L,I)+EA(GS,I)-AA(L,I)                                   REQMOD
  315 CONTINUE                                                          REQMOD
      A(1,I)=EA(1,I)                                                    REQMOD
  320 CONTINUE                                                          REQMOD
C                                                                       REQMOD
      GO TO 80                                                          REQMOD
C                                                                       REQMOD
  997 GO TO (999,998),IPRNT                                             REQMOD
  998 CALL PRINT                                                        REQMOD
  999 STOP                                                              REQMOD
      END                                                               REQMOD
```

B. SUBROUTINE—PRINT

```
      SUBROUTINE PRINT                                                  PRINT
C                                                                       PRINT
      INTEGER  AGE, FT, G, GS, PERSON, PROGT, R, RHO, S, T, TGTITL      PRINT
C                                                                       PRINT
      REAL  LAMBDA, MT, MTN, MU, MUZERO                                 PRINT
C                                                                       PRINT
      COMMON  A( 9,22), AA( 9,22), AGE, ALPHA(22), ATT(22), B(10)       PRINT
      COMMON  BE( 9,22), BETA(22), COMP(22), D(25), DT(22)              PRINT
      COMMON  EA( 9,22), ENT(22), EP(22), ET(25), ETA(6,22), FT         PRINT
      COMMON  G, GAMMA(22), GS, I, IFPOP, IPRNT, IPW, J, JUMP, K        PRINT
      COMMON  L, LA(22), LAMBDA, M, MT(22), MTN, MU(21), MUZERO         PRINT
      COMMON  N, NAC, NI(22), NN, P(4, 9,22), PERSON(25,9), PHI(22)     PRINT
      COMMON  PI(6,25), POP(10), PROGT(6,6), PSI(21), R, RHO            PRINT
      COMMON  S, SE(22), SZERO, T, TG(22), TGTITL(22,12), THETA(25)     PRINT
      COMMON  TP(25,22), TPP(6,25,22), W(6,22), WPSI(22)                PRINT
C                                                                       PRINT
      DIMENSION  TEMPTP(6,25,22), TEMPT(25,22)                          PRINT
C                                                                       PRINT
      DO 130  I=1,N                                                     PRINT
      WRITE (61,200)  I,(TGTITL(I,L),L=1,12),T                          PRINT
  200 FORMAT (1H1,7HFOR TG(,I2,4H) = ,12A4/1H0,6X,12HAT TIME T = ,I2,   PRINT
     145H, THE VALUES OF THE INDEPENDENT VARIABLES ARE/1H0/1H0,5X,      PRINT
     23HAGE,8X,6HNUMBER,4X,10HATTRITIONS,7X,4HP(1),8X,4HP(2),8X,        PRINT
     3 4HP(3),8X,4HP(4),7X,8HENTRANTS,5X,7HLARGE E,5X,20HCOMP PREV TG LA PRINT
     4ST YR    /                6X,3H---,8X,6H------,4X,10H----------,7X, PRINT
     53(4H----,8X),4H----,7X,8H--------,5X,7H-------,5X,5(4H----))      PRINT
      TEMP1=COMP(I-1)*SE(I)                                             PRINT
      TEMP=EA(1,I)-TEMP1                                                PRINT
      L=LA(I)                                                           PRINT
      WRITE (61,201)  L,A(1,I),AA(1,I),  (P(R,1,I),R=1,4),        TEMP, PRINT
     1 BE(1,I),TEMP1                                                    PRINT
  201 FORMAT (1H0,6X,I2,4X,F10.2,4X,F10.2,5X,4(F9.7,3X),     F10.2,4X,   PRINT
     1F9.7,3X,F10.3)                                                    PRINT
      NN=NI(I)                                                          PRINT
```

```
      DO 125  G=2,NN                                                    PRINT
      L=LA(I)+G-1                                                       PRINT
      WRITE (61,201)  L,A(G,I),AA(G,I),   (P(R,G,I),R=1,4),             PRINT
     1 EA(G,I),BE(G,I)                                                  PRINT
  125 CONTINUE                                                          PRINT
      WRITE (61,202)  TG(I),ATT(I),ENT(I)                               PRINT
  202 FORMAT (1HO,12X,10H----------,4X,10H----------,53X,10H----------/ PRINT
     16HOTOTAL,7X,F10.2,4X,F10.2,53X,F10.2/1HO)                         PRINT
      WRITE (61,203)  SE(I),MT(I),EP(I),DT(I),PHI(I)                    PRINT
  203 FORMAT (1HO,10X,10HSMALL E = ,F9.7/                               PRINT
     11HO,10X,21HMEDICAL TECHNOLOGY = ,F10.8/                           PRINT
     21HO,10X,24HEDUC. POLICY/PRACTICE = ,F10.8/                        PRINT
     31HO,10X,24HDIAGNOSTIC TECHNOLOGY = ,F10.8/                        PRINT
     41HO,10X,23HPARTICIPATION FACTOR = ,F10.8)                         PRINT
  130 CONTINUF                                                          PRINT
C                                                                       PRINT
      GO TO (131,134), IFPOP                                            PRINT
  131 S=0                                                               PRINT
      WRITE (61,301)  T, S, SZERO                                       PRINT
  301 FORMAT (1H1,39HFOR THE GENERAL POPULATION AT TIME T = ,I2,2H, ,    PRINT
     1 23H THE CENSUS FIGURES ARE/1HO/1HO,5X,3HAGE,10X,6HNUMBER/6X,3H--- PRINT
     2,10X,6H------/1HO,6X,I2,5X,F11.2)                                 PRINT
      DO 132  S=1,21                                                    PRINT
      WRITE (61,206)  S, PSI(S)                                         PRINT
  132 CONTINUE                                                          PRINT
      GO TO 136                                                         PRINT
  134 WRITE (61,205)  T                                                 PRINT
  205 FORMAT (1H1,39HFOR THE GENERAL POPULATION AT TIME T = ,I2,1H,/     PRINT
     11HO,2X,43HTHE VALUES OF THE INDEPENDENT VARIABLES ARE/1HO/1HO,5X,  PRINT
     23HAGE,10X,6HNUMBER,5X,13HSURVIVAL RATE/6X,3H---,10X,6H------,5X,   PRINT
     313H-------------)                                                 PRINT
      S=0                                                               PRINT
      WRITE (61,206)  S, SZERO, MUZERO                                  PRINT
  206 FORMAT (1HO,6X,I2,5X,F11.2,5X,F9.7)                               PRINT
      DO 135  S=1,21                                                    PRINT
      WRITE (61,206)  S, PSI(S), MU(S)                                  PRINT
  135 CONTINUE                                                          PRINT
C                                                                       PRINT
  136 DO 150  I=1,N                                                     PRINT
      WRITE (61,208)  T,I,(TGTITL(I,L),L=1,12),(PROGT(I,L),L=1,6)       PRINT
  208 FORMAT (1H1,12HAT TIME T = ,I2,53H, THE VALUES OF THE T/P RELATED PRINT
     1INDEPENDENT VARIABLES/1HO,2X,7HFOR TG(,I2,4H) = ,12A4,3HARE/1HO/  PRINT
     21HO,10X,34HPROGRAM TYPE DEFINITIONS -  I  =  ,6A4)                PRINT
      DO 140  RHO=2,J                                                   PRINT
      WRITE (61,209)  RHO,(PROGT(RHO,L),L=1,6)                          PRINT
  209 FORMAT (39X,I1,5H  =  ,6A4)                                       PRINT
  140 CONTINUF                                                          PRINT
      WRITE (61,210)  (W(RHO,I),RHO=1,J)                                PRINT
  210 FORMAT (1X/1HO,72X,12HPROGRAM TYPE,35X,16HWEIGHTED AVERAGE/73X,   PRINT
     112H------------,34X,16H----------------/1HO46X,1H1,13X,1H2,13X,   PRINT
     21H3,13X,1H4,13X,1H5,13X,1H6/1X/1HO,32HWEIGHTS  (PROPORTION OF CHIL PRINT
     3DREN,7X,6(5X,F9.7))                                               PRINT
      WRITE (61,215)                                                    PRINT
  215 FORMAT             (11X,16HIN EACH PROGRAM)/1HO/1X,32HPERSONNEL/PUP PRINT
     1IL CONTACTS FOR ---)                                              PRINT
      DO 145  K=1,M                                                     PRINT
      IF (TP(K,I))  142,145                                             PRINT
  142 TEMPT(K,I)=1./TP(K,I)                                             PRINT
```

```
      DO 144  RHO=1,6                                                    PRINT
      IF (TPP(RHO,K,I))  143,1433                                        PRINT
  143 TEMPTP(RHO,K,I)=1./TPP(RHO,K,I)                                    PRINT
      GO TO 144                                                          PRINT
 1433 TEMPTP(RHO,K,I)=0.                                                 PRINT
  144 CONTINUE                                                           PRINT
      WRITE (61,211) (PERSON(K,L),L=1,9),(TEMPTP(RHO,K,I),RHO=1,6),      PRINT
     1 TEMPT(K,I)                                                        PRINT
  211 FORMAT (1H0,4X,9A4,6(4X,F9.3),     (4X,F9.3))                     PRINT
  145 CONTINUE                                                           PRINT
  150 CONTINUE                                                           PRINT
C                                                                        PRINT
      WRITE (61,213)  T                                                  PRINT
  213 FORMAT (1H1,12HAT TIME T = ,I2,22H, THE REQUIREMENTS ARE/1H0/1H0,  PRINT
     14X,14HPERSONNEL TYPE,33X,15HNUMBER REQUIRED/5X,14H--------------,  PRINT
     233X,15H---------------)                                            PRINT
      DO 155  K=1,M                                                      PRINT
      WRITE (61,214)  (PERSON(K,L),L=1,9),D(K)                           PRINT
  214 FORMAT (1H0,8X,9A4,10X,F10.2)                                      PRINT
  155 CONTINUE                                                           PRINT
C                                                                        PRINT
      RETURN                                                             PRINT
      END                                                                PRINT
```